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ORIGINAL ARTICLES.

I.—On Nepheline-Syenite and its Associates in the North-West of Scotland.

By J. J. H. Teall, M.A., F.R.S., Pres.G.S.
(Communicated by permission of the Director-General.)

In 1892 I described, in conjunction with my colleague Mr. Horne, a peculiar rock, essentially composed of orthoclase and melanite, under the name of borolanite.[1] The type-specimens came from the plutonic mass which lies to the north of Loch Borolan, in Sutherlandshire (1 in. sheet 101). During the preparation of the paper on borolanite our colleague Mr. Gunn discovered two dykes of a closely related rock traversing the Torridon Sandstone in the Coigach district of West Ross-shire. The rock of these dykes was described in an appendix to our paper. It contains nepheline and ægirine, in addition to orthoclase and melanite, and is therefore allied, both as regards mode of occurrence and mineralogical composition, to the Tinguaite group of Rosenbusch; but as melanite is an important constituent it was classed with the borolanites.

At the conclusion of our paper we say: "The affinities of borolanite are unmistakeable. It is a member of the foyaite (elæolite-syenite) family. The occurrence of melanite as an important accessory in certain rocks belonging to the nepheline-leucite group has long been recognized. In our rock we have melanite raised to the rank of an essential constituent. Borolanite, as we have already shown, is intrusive in the Cambrian rocks of Sutherlandshire. The nearest rocks in any way allied to it are the elæolite-syenites of the Christiania district, which are also intrusive in Lower Palæozoic strata."

Since this paper was written I have had the privilege of visiting the Christiania district, under the guidance of Professor Brögger, and the experience thus gained has been of the greatest service in a re-examination of the post-Cambrian igneous rocks of the north-west of Scotland — a re-examination rendered necessary by the preparation of the Geological Survey memoir on that district. Some of the results thus brought to light, especially the recognition of true nepheline-syenites, as well as other rocks closely allied to types described by Prof. Brögger in his classic memoirs on the Christiania

[1] "On Borolanite: an Igneous Rock intrusive in the Cambrian Limestone of Assynt, etc.": Trans. Roy. Soc. Edin., vol. xxxvii (1892), pp. 163–178.

district, appear to be of sufficient interest to justify a brief preliminary notice, which it is the purpose of this communication to supply.

The work of previous observers on the rocks in question is described in the paper on borolanite above referred to, and need not therefore be repeated in detail; but there is one name I desire especially to mention in the present connection, namely, that of Dr. Heddle. In one of his papers on the geognosy and mineralogy of Scotland[1] he gives chemical analyses of the porphyritic felspars and of the groundmass of a "hornstone porphyry" from the south-east spur of Ben Brachaid. Both agree very closely with albite in composition. Thus the credit of establishing the existence of rocks formed by the consolidation of an alkaline magma exceptionally rich in soda, in the Assynt district, unquestionably belongs to Dr. Heddle.

The post-Cambrian igneous rocks of the north-west of Scotland occur in two forms—as plutonic masses and as sills and dykes; or, in other words, as abyssal and hypabyssal rocks. No lavas or effusive rocks of any kind are known. The only important plutonic mass is the one stretching from Ledbeg for about five miles in a south-easterly direction, with an average width of about one mile. Cnoc na Sròine (1,306 feet) forms the culminating point. The dominant rock of this mass is a red granite or syenite, remarkably free from ferro-magnesian or any other dark-coloured constituents. It was described by Nicol as a red felspar porphyry, and by Murchison as a syenite. Dr. Heddle pointed out that true porphyritic structure is absent,[2] and that the rock is composed mainly of red felspar, often much stained and decomposed; quartz being always subordinate to the felspar and sometimes absent altogether.

The specimens in the Survey collection agree with Dr. Heddle's descriptions. Those in which quartz is present have the aspect of somewhat coarse-grained binary granites, while those in which it is absent resemble syenites. Ferro-magnesian constituents are extremely rare in the main mass of Cnoc na Sròine, but they occur abundantly in some of the peculiar rocks found on the margins. A specimen from the burn behind the inn at Aultnacallagach (3,082)[3] is a coarse-grained red granite or quartz-syenite, composed mainly of felspar, but containing also a few blebs of quartz and some insignificant dark specks representing a ferro-magnesian mineral. Under the microscope two felspars are recognizable. The plagioclase occurs in more or less idiomorphic crystals, which are often zoned and always twinned on the albite plan. The twin lamellæ are numerous and very narrow. The second felspar occurs in large, irregular plates, and shows moiré-structure under crossed nicols. It is often twinned on the Carlsbad plan, and frequently contains inclusions of idiomorphic plagioclase. Quartz occurs in

[1] Mineralogical Magazine, vol. v (1884), p. 141.

[2] A specimen in the Survey collection (3,081) from the summit of Cnoc na Sròine shows a half-porphyritic structure such as is occasionally found on the margin of Brögger's nordmarkite.

[3] The numbers in parentheses refer to the registered specimens in the collection of the Geological Survey.

irregular grains. The ferro-magnesian mineral is represented by minute scales of a bright green chlorite.

When the powder of the rock is placed in a Sollas' diffusion column three well-marked bands are formed: one corresponding to quartz, which is present only in small quantity (2·65); another corresponding to albite (2·62); and a third at a level just below the point at which orthoclase floats. Although the specific gravity of the plagioclase corresponds very closely with that of albite, the extinctions on M-flakes are not quite equal to albite—15° to 17° as against 19°. The difference is so slight that in the descriptions which follow the term albite[1] will be used. The second felspar, being slightly denser than orthoclase, is probably rich in soda, and may be cryptoperthite or anorthoclase, but the optical characters, so far as I have been able to determine them, agree with orthoclase, and in the absence of analyses I prefer to use that term. Of the two felspars albite is the more abundant.

Another specimen from Cnoc na Sròine (3,090) is very similar in general appearance to the one just described, but contains less quartz. Two felspars are recognizable under the microscope, but they are more intimately intergrown, and often assume the character of microperthite. Both are deeply stained with ferric oxide, and opaque iron-ore occurs as an accessory constituent.

Other red rocks from the same mass are true syenites without quartz, and these sometimes contain pseudomorphs after nepheline with accessory melanite (3,083). The felspars in these cases are either orthoclase or microperthite.

The more acid varieties of the red rocks have affinities with the nordmarkites of Professor Brögger. They resemble them in the abundance of alkali-felspars and in the paucity of both quartz and ferro-magnesian minerals. When the two felspars are intergrown microperthitically the resemblance is very close, but when the albite is independently developed as idiomorphic crystals it is not so close. Taking the mass as a whole, the alkali-granites or quartz-syenites appear to shade into quartzless syenites, and these again into nepheline-syenites.

In the red rocks which form the main mass of Cnoc na Sròine no fresh nepheline has been detected; but a coarse-grained dark-green rock (3,095) from the foot of the north slope of the mountain contains this mineral in abundance, and is, in fact, a true nepheline-syenite. The weathered surface is rough owing to the more rapid weathering of the nepheline, which has a dull green, waxy appearance. The alkali-felspar is developed in flat tables with conspicuous development of the clinopinacoid, and the crystals

[1] It may be of interest to mention that in the metamorphic rocks (albite-schists and gneisses) I have always found the albite to give the theoretical extinction of 19° on M-flakes. The mineral appears to be perfectly homogeneous and ideally pure, except as regards inclusions. But I have never observed the theoretical extinction of 19° in a plagioclase occurring as a normal constituent of an igneous rock. In the case above described the breadth of the band in the diffusion column, the zonal structure seen in the sections, and the slightly varying extinctions on the M-flakes, all indicate that the mineral is not perfectly homogeneous.

are often twinned on the Carlsbad plan. Under the microscope the rock is seen to be composed of nepheline and alkali-felspar in approximately equal proportions. A greenish biotite and melanite occur as accessory constituents. Both felspar and nepheline are present as large individuals, measuring half an inch or more across. The occurrence of melanite as an accessory constituent serves to emphasize the close relation between nepheline-syenite and borolanite.

The typical borolanites have been described in the paper above referred to. They are extensively developed to the east of Aultnacallagach in the low ridge on the north-eastern side of the road leading from Oykell Bridge to Inchnadampf, and occur also at other points on the borders of the plutonic mass. One specimen (3,737) may be briefly referred to as a type. It is a massive rock composed of white patches, measuring one-quarter to three-quarters of an inch across and often polygonal in outline, embedded in a dark, almost black matrix. The white patches correspond to the pseudo-leucites described by Derby, Hussak, and J. F. Williams. They are composed mainly of orthoclase, which is often micrographically intergrown with an alteration product after nepheline. Biotite and ægirine-augite occur sparingly in these patches. The matrix is composed of orthoclase and melanite with some ægirine-augite and biotite. Micrographic intergrowths of orthoclase and the alteration product after nepheline are also present.

The rocks most nearly allied to these peculiar borolanites are unquestionably the 'leucite-syenites' from the igneous complex of Magnet Cove, Arkansas, described by the late J. F. Williams,[1] whose early death was such a severe loss to American petrology. Williams speaks of these and other rocks of the complex as forming dykes; but the geological map of the district accompanying his memoir clearly shows that they do not occur as ordinary dykes. According to Dr. Washington[2] the complex represents a laccolite in which differentiation has produced a mass varying in composition from a highly basic jacupirangite at the centre to foyaite at the margin. The different types—foyaite, leucite-porphyry, shonkinite, ijolite, biotite-ijolite, and jacupirangite — succeed each other in concentric zones from the margin to the centre, the rock most nearly allied to borolanite coming second in the series, reckoning from the outside. This rock is described by Williams as "a hypidiomorphic granular combination of pseudo-leucite, eleolite, orthoclase, and basic silicates, which presents a more or less perfect granitic structure and is genetically connected with the eleolite-syenite dike rocks." The pseudo-leucites are composed mainly of orthoclase and nepheline, as are those of our borolanite, but they are more perfect in form. It must, however, be remembered that the borolanite area has never been searched for specimens showing the forms of

[1] "The Igneous Rocks of Arkansas": Annual Report of the Geological Survey of Arkansas for 1890, vol. ii.

[2] "Igneous Complex of Magnet Cove": Bull. Geol. Soc. Amer., vol. ii (1900), pp. 389–416.

leucite. Those specimens which have been collected frequently show polygonal outlines strongly suggestive of icositetrahedra, and it is highly probable that more perfect forms will be found. The groundmass of the leucite-syenite consists principally of eleolite, black garnets, and orthoclase. A green pyroxene, biotite, and sphene are also present. Melanite, according to Williams, "is found in varying quantities in the different specimens. In some it is almost entirely wanting, while in others it forms a very important factor. It is of a rich brown or yellowish-brown colour, decidedly zonal in its structure, and isotropic in its optical properties. . . . . In some cases more than half the area inclosed within the boundaries of the section consist of melanite material."

This description leaves no doubt that those portions of the 'leucite-syenite' of Magnet Cove in which melanite is most abundant are practically identical with the borolanite of Assynt. This conclusion is confirmed by a comparison of the chemical analysis of the borolanite dyke discovered by Mr. Gunn with that of the rock described by Williams.

	I.	II.
SiO_2	47·8	50·96
Al_2O_3	20·1	19·67
Fe_2O_3	6·7	7·76
Fe O	·8	...
Mg O	1·1	0·36
Ca O	5·4	4·38
Na_2O	5·5	7·96
K_2O	7·1	6·77
H_2O (Ig.)	2·4	1·38
TiO_2	·7	·52
SO_3	·4	...
Mn O	·5	tr.
Ba O	·8	...
Cl	...	·25
	99·3	100·01

I. Borolanite dyke, Camas Eilean Ghlais. Analysis by Player.

II. 'Leucite-syenite,' Magnet Cove. Analysis by Noyes.

Another rock somewhat allied to borolanite is the ijolite of Ramsay and Berghell.[1] It is essentially composed of nepheline, pyroxene, and a titaniferous melanite (jiwaarite).[2]

In addition to borolanite there are some other interesting modifications of the syenitic magma, apparently detached from the main mass, near Ledbeg at the contact with the marble. One of these (4,288) is a dense, dark-green rock, composed of a green pyroxene and orthoclase or moiré-microcline with sphene as an important accessory; another (3,088), also dark in colour, is composed of ægirine-augite, orthoclase, pseudomorphs after idiomorphic nepheline, and rich brown sphene. Both are augite-syenites, one containing nepheline and the other not.

[1] "Die Gesteine von Jiwaara in Finland": Geol. Foren. Stockholm Forandl., xiii, (1891), p. 300.

[2] It is quite possible that some varieties of the melanite of the borolanite may be titaniferous, but in order to prove this the material analyzed would have to be very carefully examined under the microscope, as the mineral is not unfrequently crowded with minute inclusions of sphene.

The facts above described clearly prove that we have in the plutonic complex of Loch Borolan a connected group of rocks formed by the consolidation of alkaline magmas rich in soda. At one end of the series is the alkali-granite or quartz-syenite forming the main mass of Cnoc na Sròine, and at the other end of the series the basic augite-syenite, nepheline-syenite, and borolanite. The basic varieties occur on the margin and the acid varieties in the centre. This arrangement is the opposite of that occurring in the igneous complex of Magnet Cove.

To what extent the different rocks represent successive intrusions, differentiation *in sitû*, or the result of a modification in the composition of the original magma by the absorption of adjacent limestones, has not been clearly made out. It is quite possible that all three operations will have to be taken into account in explaining the phenomena observed. The evidence available suggests that the quartz-syenites shade into quartzless syenites, and these again into nepheline-syenites. Albite is abundant in the most acid rocks, either in the form of independent crystals or as microperthitic intergrowths with orthoclase. But as nepheline comes in, albite disappears, and in the more perfect types of nepheline-syenite no soda-felspar is recognizable. It is clear, even without chemical analyses, that the presence of nepheline is determined by the ratio of silica to alumina to soda. With excess of silica albite is formed, and when there is a deficiency of silica nepheline is produced. In the more acid rocks albite, or an extremely acid oligoclase, shows a strong tendency to idiomorphism, and precedes both orthoclase and quartz. In the less acid varieties it frequently occurs intimately intergrown with orthoclase.

There is no constancy in the order of appearance of nepheline and orthoclase. In some specimens idiomorphic nepheline occurs as inclusions in large patches of orthoclase (micropœcilitic structure), in others orthoclase is idiomorphic with respect to nepheline, while in the pseudo-leucites and even in the groundmass of certain borolanites the two minerals form beautiful micrographic intergrowths. Thus, nepheline may precede orthoclase, orthoclase may precede nepheline, or the two minerals may crystallize simultaneously. Similar relations between alkali-felspar and nepheline have been described by Professor Brögger as occurring in the laurdalites of the Christiania district.

But the series does not end with nepheline-syenite. This rock sometimes contains ægirine-augite and melanite. By an increase in the former it passes into augite-syenite, and by an increase in the latter into borolanite. The borolanites and augite-syenites may or may not contain nepheline.

The general result of this re-examination of the specimens collected at various times from the plutonic mass of Loch Borolan has been to confirm and extend the conclusion arrived at by Mr. Horne and myself as to the relations between the igneous rocks of Assynt and those of the Christiania district. Quartz-syenites, syenites, augite-syenites, and nepheline-syenites are all

represented either in the main mass or in its immediate neighbourhood. But the resemblance extends still further to some of the hypabyssal rocks—the dykes and sills. A glance at the maps (Sheets 101 and 107) will show that the Cambrian area to the north of the plutonic mass is traversed by numerous sills and dykes. These belong to two strongly marked types — dark-coloured hornblendic rocks (camptonites or vogesites) and light-coloured felspathic rocks (felsites). A description of the hornblendic rocks has already appeared in the pages of this Magazine,[1] and they need not further be referred to at present. A full description of the felsites must be postponed until analyses are available, but one or two varieties may be briefly described, as they are clearly allied to certain peculiar rocks occurring in the Christiania district.

The first of these is a dyke from Poll an Droighinn, near Inchnadampf (2,324). The rock is a pale-green felsite, with somewhat obscure indications of porphyritic felspars and decided traces of parallel structure. Under the microscope it is seen to be composed of polysynthetic aggregates, representing original porphyritic alkali-felspars, streaks of microcrystalline quartz (scarce), and a crypto- or microcrystalline felspathic matrix *crowded with acicular microlites of ægirine.* Similar microlites occur in the polysynthetic aggregates, as they do in the phenocrysts in Professor Brögger's grorudite, but they are far less numerous than in the matrix, where they are often so thickly crowded together as to form a felt-like mass. The larger microlites are green, but the smaller ones are colourless; both show the characteristic optic characters of ægirine when isolated from the felspathic material. This rock is a variety of grorudite.

Another very interesting type of felsite, found by Mr. Peach, is intrusive in the Lewisian gneiss in a burn one-quarter of a mile north of the top of Sgònnan More (8,370). This consists of numerous phenocrysts of pink felspar, usually giving rectangular sections and measuring about a quarter of an inch across, embedded in a compact light-grey felsitic matrix. Under the microscope the phenocrysts are seen to consist of intergrowths of albite and orthoclase, similar to those observed in the plutonic mass of Cnoc na Srôine. The groundmass is a micro- or cryptocrystalline aggregate of alkali-felspar, containing a few minute, ragged prisms of ægirine. A little free quartz is probably present, but cannot be identified with certainty under the microscope. This rock contains much less ægirine than the typical grorudites, and in this respect more closely resembles the lindöites of Professor Brögger.

Analyses of these rocks will be made, and until this has been done a further discussion of their affinities seems scarcely desirable. This much is certain. They are composed mainly of alkali-felspar with some free quartz and ægirine, and they are closely allied to grorudites, from which they differ chiefly in containing rather less ægirine.

[1] "Notes on some Hornblende-bearing Rocks from Inchnadampf," by J. J. H. Teall: Geol. Mag., 1886, pp. 346–353.

The grorudites of Professor Brögger form the acid extreme of a well-defined rock-series of which, so far as the Christiania district is concerned, tinguaite is the basic extreme. No rocks answering to tinguaites in chemical composition have been found in the north-west of Scotland. The dykes discovered by Mr. Gunn in west Ross-shire, to which the term borolanite was extended, not without hesitation, as melanite is far less abundant than in typical borolanite, are composed mainly of nepheline, orthoclase, and ægirine, and therefore allied to tinguaites in mineralogical composition; but the rock analyzed contains over 5 per cent. of lime—a fact which sharply differentiates it from typical tinguaites. Another point which differentiates these dykes from tinguaites is their structure. Nepheline, ægirine, melanite, and biotite occur as idiomorphic crystals in large irregular patches of orthoclase (micropœcilitic structure) But if these dykes do not fit into the grorudite-tinguaite series they correspond very well with some of the more basic members of the plutonic mass of Cnoc na Sròine, with the nepheline-melanite syenites, just as the grorudite-like rocks correspond with the more acid portions of the same mass. It is probable, therefore, that both are aschistic, in Professor Brögger's sense, and that they represent the dyke forms of the magmas which gave rise to the plutonic mass.

In the foregoing account of this small but extremely interesting petrographical province, special emphasis has been laid on its relations to the Christiania district; but it might equally well be compared with other districts in which nepheline-syenites occur. Each of these districts has its own special features. The occurrence of borolanite is a peculiarity which the district in question shares, so far as we know at present, only with that of Magnet Cove.

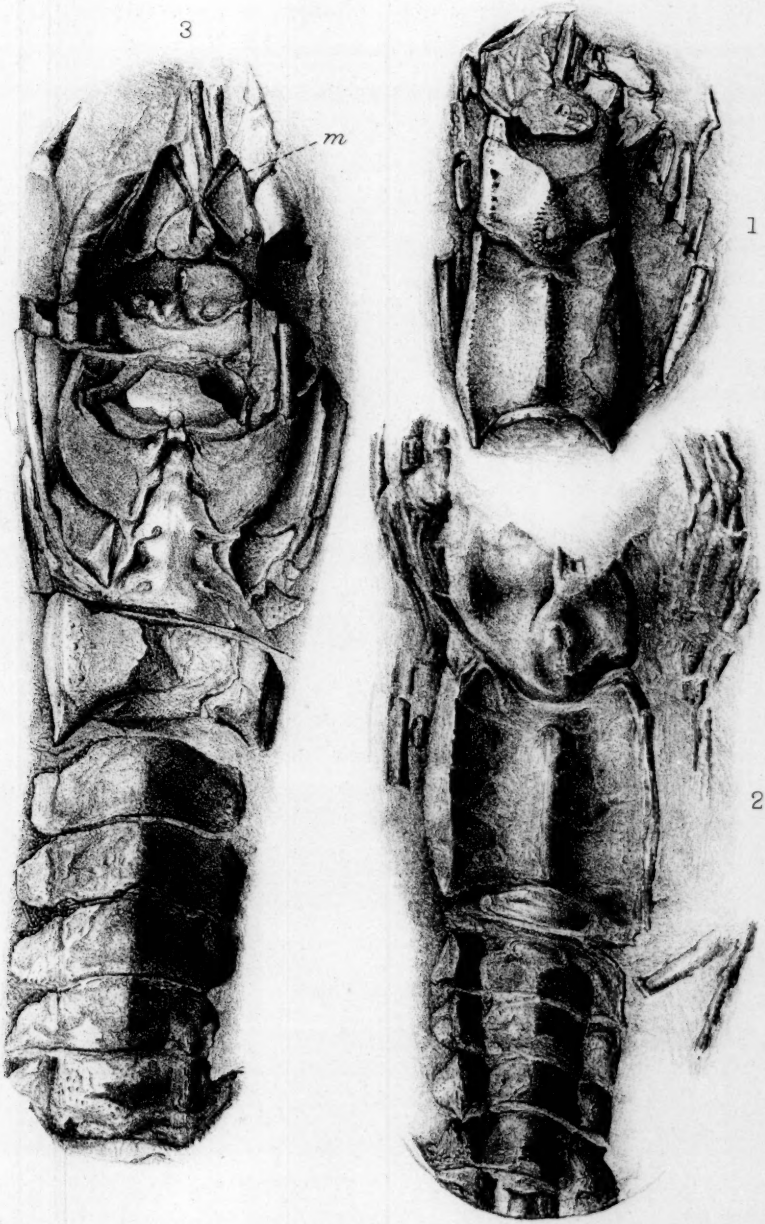
II.—Further Notes on Podophthalmous Crustaceans from the Upper Cretaceous Formation of British Columbia, etc.

By Henry Woodward, LL.D., F.R.S., F.G.S., etc., of the British Museum (Natural History).

(PLATES XV and XVI.)

IN 1896 I described some decapod Crustaceans found in the Cretaceous formation of Vancouver and adjacent islands, British Columbia, which, with the approval of Dr. G. M. Dawson, C.M.G., F.R.S., the Director, had been most kindly placed in my hands for examination by Dr. J. F. Whiteaves, F.G.S., Palæontologist to the Geological Survey of Canada. They were referred by me to the genera *Callianassa*, *Homolopsis*, *Palæocorystes*, and *Plagiolophus* (see Quart. Journ. Geol. Soc., 1896, vol. lii, pp. 221–228, with 6 figures).

From the same source I have since received a further and much larger collection of specimens from the Nanaimo and Comox Group (Upper Cretaceous). Like the earlier series, all these Crustaceans are preserved in hard concretionary nodules, which render their examination in detail often extremely difficult and disappointing, as



G.M. Woodward & H.B. Potter.

West, Newman imp.

Decapod Crustaceans
U. Cretaceous Vancouver Island, B.C.

they split unevenly with a jagged fracture, and have also a tendency to divide up into cuboidal fragments.

The material which has now been placed in my hands may be summarized thus:—

No. 1. One specimen of a dark nodule, split into halves ($3'' \times 1\frac{3}{4}''$), exposing the cephalothorax and portions of the limbs of a Crustacean referred to *Linupārus* (*Podocrates*) *Vancouverensis* by Whiteaves (Pl. XV, Fig. 1), described in Trans. Roy. Soc. Canada, ser. II, vol. i (1895–6), sect. 4, pp. 132 and 133. Formation: from the Nanaimo Group (Upper Cretaceous), Museum Geol. Surv. Canada. Locality: from two miles up the Puntledge (called also the Comox) River, Vancouver Island; collected by the Rev. G. W. Taylor, 1889.

No. 3 (labelled also 58 in white paint). A large dark nodule, split in halves ($6\frac{3}{4}'' \times 3\frac{3}{4}''$), exposing the dorsal aspect of a second specimen of *Linupārus* (*P.*) *Vancouverensis*, W., showing the cephalothorax and a portion of the base of the left antenna. The three characteristic longitudinal ridges, the small central pear-shaped area in front of the neck-furrow on the carapace, and five of the abdominal segments can also be seen (Trans. Roy. Soc. Canada, op. cit.). Formation: Upper Cretaceous. Locality: Hornby Island; coll. by W. Harvey, 1893.

No. 4. A long, dark, and rather cylindrical nodule ($6\frac{1}{2}'' \times 2\frac{1}{2}''$), split in halves and also broken across transversely, exposing the interior of the cephalothorax and five segments of the abdomen of *Linupārus* (*P.*) *Vancouverensis*, W. (Pl. XV, Fig. 3). The upper surface of the carapace is not preserved, but the bases of the mandibles (*m.*) are exposed, the monodactylous walking-legs, and the bases of the antennules. The epimeral portions of the abdominal segments are serrated behind, and bear small tubercles on the surface. Formation: Upper Cretaceous. Locality: Comox River, Vancouver Island; coll. by J. B. Bennett, 1895.

No. 6. Half of a nodule only ($7'' \times 4\frac{3}{4}''$), containing an obscurely preserved Crustacean, *Linupārus* (*P.*) *Vancouverensis*, showing characteristic traces of the carapace and limbs and the nearly entire abdomen, including remains of the caudal appendages. The posterior borders of the epimera are spinous. The right antenna is preserved for a length of $2\frac{1}{2}$ inches. Formation: Upper Cretaceous. Locality: Hornby Island; coll. by W. Harvey, 1895. (Specimen also marked No. 1 in ink.)

No. 55 *a* and *b*. Two sides of a dark egg-shaped nodule split open ($4\frac{1}{2}'' \times 3\frac{3}{8}''$), exposing the dorsal aspect of a specimen of *Linupārus* (*P.*) *Vancouverensis*, W. (Pl. XV, Fig. 2), showing the carapace and the five abdominal segments, also the remains of the caudal appendages and the thoracic limbs. The three characteristic ridges are well seen, also the cervical furrow, with its pear-shaped tuberculated area just in front. Formation: Upper Cretaceous. Locality: Hornby Island; coll. by Mr. Robbins in 1896, Provincial Museum, Victoria, British Columbia.

A few additional specimens from the same series are referred to later on.

NOTES ON THE GENUS *Linupārus*, A. White, 1847.

Before proceeding further it seems desirable to say a few words upon the nomenclature of this genus, which, like the materials illustrating it, has greatly increased and become somewhat complicated.

In 1884 Dr. Whiteaves first called attention to these interesting Palinurids in the Transactions of the Royal Society of Canada (vol. ii, sect. 4, pp. 237, 238) under the provisional generic name of *Hoploparia* (?), with the specific designation of *Canadensis* for the form then under discussion, obtained from the Cretaceous of Highwood River, a tributary of the Bow River.

This fossil was again described by Dr. Whiteaves (in 1885) under the name of *Hoploparia* (?) *Canadensis* in "Contributions to Canadian Palæontology," 1885, vol. i, pp. 87–89, where it is figured for the first time (pl. xi). It appears that some time afterwards (1890) Dr. C. Schlüter, of Bonn, stated that the so-called *Hoploparia* (?) *Canadensis* was closely allied, if not identical with, his *Podocrates Dulmenensis*, a name proposed by Becks (without description), but described fully by Dr. Schlüter in 1862 (in the Zeitsch. der Deutsch. Geol. Gesellsch., xv, pp. 710–716, taf. xii). This genus *Podocrates* was also adopted by Fritsch & Kafka in their "Crustacea Böhm. Kreidform.," pp. 20, 21, taf. iii, figs. 1 and 2 and text-fig. 44, Prague, 1887.

In 1895 Dr. J. F. Whiteaves added a new species of Cretaceous Palinurid to the series of Crustaceans already recorded by him from the Cretaceous of Vancouver (Proc. and Trans. Roy. Soc. Canada, ser. II, vol. i, sect. 4, pp. 132, 133), under the name of *Podocrates Vancouverensis*, thus accepting and acknowledging the correctness of Dr. Schlüter's earlier determination in 1862.

Two years later, Dr. A. E. Ortmann described a new species of Palinurid, from the Upper Cretaceous of Dakota, under the generic name of *Linuparus*, Gray (1847), a monotypic genus containing only the single living Japanese species *Palinurus trigonus* of De Haan (see De Haan, in Siebold's "Fauna Japonica," Crustacea, 1841, p. 157, pls. xxxix and xl). This genus *Linupārus*,[1] attributed to Dr. John Edward Gray ("List of Crustacea in the British Museum," p. 70), as pointed out by the Rev. T. R. R. Stebbing, F.R.S. ("A History of Crustacea," 1893, p. 197), (spelt by him *Linupāris*), is *not* Dr. Gray's name, but was given by Adam White in 1847; "the characters of the new genus being left to be inferred from the known species (as described by De Haan), a very slovenly method of definition which is much to be deprecated" (Stebbing, op. cit.).

LINUPĀRUS VANCOUVERENSIS, Whiteaves, sp. (Pl. XV, Figs. 1–3.)

1841. *Palinurus trigonus*, De Haan, Fauna Jap. Crustacea, p. 157, pls. xxxix, xl.
1847. *Linuparus trigonus*, White (gen. emend.), List Crustacea Brit Mus., p. 70.
1857. *Thenops*, Bell, Foss. Malacost. Crust., pp. 33, 34, pl. vii: Pal. Soc. Mon., 1857.

[1] This name is an anagram on Fabricius's genus *Palinurus*, from which *Linupārus* was separated by Adam White, the real author of the "List of Crustacea in the British Museum," 1847.

1862. *Podocrates* (Becks, nom. nud.), Schlüter, Zeitsch. der Deutsch. Geol. Gesellsch., xiv, 1862, pp. 710–716, taf. xii.
1887. *Podocrates*, Fritsch & Kafka, Crust. Böhm. Kreidform., pp. 20, 21, taf. iii, figs. 1 and 2 and text-fig. 44.
1893. *Linupāris* (*sic*), Stebbing, Hist. Crustacea, p. 197.
1895. *Podocrates*, Whiteaves, Trans. and Proc. Roy. Soc. Canada, 1895, ser. II, vol. i, sect. 4, pp. 132, 133.
1897. *Linuparus*, Ortmann, Amer. Journ. Sci., ser. IV, vol. iv, pp. 290–297, figs. 1–4 in text.

At the meeting of the Royal Society of Canada, May, 1895, Dr. J. F. Whiteaves gave descriptions of the fossils from the Nanaimo group of the Vancouver Cretaceous series, and among others described a new species of Crustacean, of which description I subjoin a copy.

LINUPĀRUS (PODOCRATES) VANCOUVERENSIS, Whiteaves, sp.

"Carapace flattened, rectangular, longer than broad, marked by three low angular tuberculous or spinose longitudinal ridges, one in the median line and one near each of the lateral margins, and divided at about one-third the distance from the front by an obtusely subangular cervical groove, which is rather broad but not very deep. On the anterior portion or cephalic arch the lateral longitudinal ridges are well developed, and armed with larger and more spinose tubercles than those on the corresponding ridges of the posterior portion, one a little behind the mid-length on each ridge being larger than any of the others, but the central ridge is obsolete. In its place, just in advance of the cervical groove, there is an ovate lanceolate or narrowly spear-shaped area, which is elevated at the pointed end anteriorly, shallowly depressed posteriorly, and margined with a single row of small tubercles. Immediately in front of this area there is a pointed or spinose tubercle, almost in a line with the largest tubercle on each of the lateral ridges, and still farther forward there are two similar tubercles at a short distance from the anterior margin and about seven millimetres apart. On the posterior portion, or scapular arch, the three longitudinal ridges are minutely tuberculated, and extend from the posterior margin to the cervical groove, where they each terminate in a pointed tubercle larger than any of the rest, but the central ridge is shorter than either of the two lateral ridges. Anterolateral angles of the carapace each armed with a nearly straight but slightly divergent spine. Rostrum, central portion of the anterior margin, and position of the eyes unknown. External antennæ broad and flattened at their bases, inner antennæ cylindrical at theirs. Walking feet slender, as is usual in the genus. In addition to the spines and tubercles on the lateral ridges and elsewhere, as already described, the whole of the upper surface of the carapace is minutely granulose and apparently setose, numbers of minute objects, which seem to be detached setæ, being plainly visible under an ordinary lens."

"Two miles up the Puntledge River, Vancouver Island, Rev. G. W. Taylor, 1889: a good specimen of the carapace, with the rostrum and a small piece of the anterior broken off, but with considerable

portions of the ambulatory feet and the bases of the inner and outer antennæ preserved. This interesting fossil is now in the Museum of the Geological Survey of Canada. [See Pl. XV, Fig. 1.]

[No. 3.] "Hornby Island, W. Harvey, 1893: a less perfectly preserved specimen, showing most of the carapace (but not the rostrum), portions of the ambulatory feet, and the dorsal aspect of five segments of the abdomen (their margins were denticulated).

"In 1884 (Trans. Roy. Soc. Canada) the writer [Dr. J. F. Whiteaves] described a long-tailed decapod crustacean from the Cretaceous rocks at the Highwood River in Alberta, under the provisional name *Hoploparia* (?) *Canadensis*. Dr. C. Schlüter, of Bonn, Germany, in a letter dated February 20, 1890, expresses the opinion, which appears to be well founded, that this species, which is figured on plate ii of the first part of the first volume of 'Contributions to Canadian Palæontology,' is a *Podocrates*, closely allied to, if not identical with, the *P. Dülmensis* of Becks. *P. Vancouverensis* seems to differ from that species in the much smaller proportionate size of the tubercles on the three longitudinal ridges on its carapace, especially posteriorly, and in the different arrangement of the distant spinose tubercles on the anterior moiety of its cephalic arch."

The publication of Dr. Ortmann's paper (American Journal of Science, ser. IV, vol. iv, 1897, pp. 290–297, figs. 1–4) makes us acquainted with another species of Palinurid, which he names *Linuparus atavus*, from the Upper Cretaceous of Cotton Wood Creek, Mead Co., South Dakota.

There is no doubt that this form is closely related generically with *P. Canadensis*, *P. Vancouverensis*, Whiteaves, and also with *P. Dulmenensis*, Schlüter, and that for all these species Adam White's genus *Linupārus* (1847) takes priority over the other genera to which they have heretofore been referred by various authors.

Formation: Upper Cretaceous.

Locality: Puntledge or Comox River (Fig. 1), Hornby Island (Fig. 2), Comox River (Fig. 3), British Columbia.

In the "Contributions to Canadian Palæontology" for 1885, vol. i, pp. 87–89, pl. xi, Dr. J. F. Whiteaves, F.G.S., published the following description of *P. Canadensis*, a decapod Crustacean from the Upper Cretaceous of Highwood River, Alberta, N.W.T., which we here reproduce:—

LINUPĀRUS (PODOCRATES) CANADENSIS, Whiteaves, sp.

Hoploparia (?) *Canadensis*, Whiteaves, 1884.[1]

"The fossil, which it is the more immediate object of this paper to describe, is a rather remarkable example of a macrourous decapod crustacean, collected by Mr. R. G. McConnell in 1882 from the Cretaceous shales of the Highwood River, a tributary of the Bow, ten miles west of the first fork.

"The specimen originally consisted of an elongate-oval and

[1] Trans. Roy. Soc. Canada, vol. ii (1884), sect. 4, pp. 237, 238.

flattened concretionary nodule of soft argillite, with a small piece broken off from one end, but enough of the matrix has been removed to show most of the carapace and the upper surface of a few of the abdominal segments. The anterior extremity of the carapace, with the rostrum, is unfortunately not preserved, and the tail, with some of the posterior abdominal segments, was broken off when the nodule was found. The ambulatory feet are preserved, but it was found to be scarcely possible to remove the soft shale from around them without running the risk of spoiling the specimen.

"The carapace, like that of most of the macroura, is elongated and comparatively narrow, with nearly parallel sides, and, when perfect, its length must have been about twice as great as its breadth. A little in advance of the mid-length a single, broadly V-shaped, deep, and rather wide cervical furrow crosses the carapace transversely. The posterior half of the carapace is depressed and rather distinctly three-keeled in a longitudinal direction. In the specimen collected by Mr. McConnell a central keel, or narrow but prominent raised ridge, about three times as broad posteriorly as it is anteriorly, and which is bounded on each side by a deep and angular furrow, extends from the posterior end of the carapace to the centre of the V-shaped (cervical) groove which transverses it. This central keel is much more strongly marked than the broad and comparatively obtuse lateral keels near the outer margin of each side. The surface of the posterior half of the carapace (and perhaps that of the anterior also) is covered with rather distant, small, isolated conical tubercles, which occasionally are surrounded by a minute annulus at the base; and the three keels each have a single series of larger conical tubercles, whose pointed apices are directed forward.

"In front of the transverse and V-shaped (cervical) furrow the carapace is very badly preserved, and the anterior margin with the rostrum is broken off. The two lateral and tuberculated keels appear to be prolonged to within a short distance of the front margin of the carapace, though they are somewhat less distinct in front of the (cervical) furrow than they are behind it. On the anterior side of the furrow the central keel is absent, and the median portion of this part of the carapace bears a number of comparatively large and prominent, distinct and conical tubercles, which are somewhat peculiarly arranged. Next to the furrow, and in advance of it, in the median line, there are five tubercles arranged in two convergent rows of two pairs and an odd one, which, if connected by lines, would have much the shape of an isosceles triangle, with its base near to the furrow. Between the space bounded by these five tubercles and each lateral keel there is a shallow, concave, and rather broad depression of the carapace. In front of these five tubercles, again, there are four others and still larger ones (the two anterior ones apparently of considerable size), arranged somewhat in the form of a square, any of whose sides would be greater than the base of the isosceles triangle indicated by the other five.

"The upper surface of each of the abdominal segments bears a tubercle in the centre, on its anterior edge, and another one on the margin of each of the sides. The most prominent characteristic

of the species, in fact, is the possession of three widely distant, longitudinal, and tuberculated keels, which extend over nearly the whole length of the upper surface of the body." . . . .

"Judging by the invertebrate fossils alone, it would seem probable that the friable and fissile shales at Mill Creek, which hold typical examples of *Inoceramus problematicus*, may represent the 'Niobrara Group' of the Upper Missouri section. On similar evidence, also, the rocks of the two localities on the Waterton River, which have yielded respectively *Ostrea congesta* and *Volviceramus exogyroides*; those at the Highwood River, which contain *Inoceramus undabundus* and *Scaphites Warreni*; those on the north-west branch of the north fork of the Old Man River, from which *Inoceramus undabundus*, *Pholadomya papyracea*, *Scaphites Warreni*, and *S. vermiformis* were collected; and those at the entrance to the North Kootanie Pass, which are characterized by *Volviceramus exogyroides*, *Scaphites Warreni*, and *S. vermiformis*, would appear to be as nearly as possible the Canadian equivalents of the 'Fort Benton Group.'

"In conclusion, it may be remarked that the invertebrate fauna of the 'Belly River Series' seems to be essentially the same as that of the 'Laramie' of the United States and Canada, unless more than one formation has been confounded under the latter name, and that it is at present scarcely possible to separate the 'Lower Dark Shales' of Dr. Dawson's Bow and Belly River Report from the 'Fort Pierre and Fox Hills' Groups on purely palæontological grounds."[1]

Additional note on *Linupārus Canadensis* (Pl. XVI, Fig. 1), by H. Woodward.—No. 55 *c*. One half of a dark nodule ($6\frac{1}{4}'' \times 4''$), exposing the under side of a large Crustacean, showing the five sternites and the bases of the thoracic limbs. I have referred this specimen to Dr. Whiteaves' species *L. Canadensis*, with which it agrees in size, being one of the largest specimens of the fossil Palinurids from this locality.

It exhibits the under surface of the cephalothorax, with the sterna and the basal joints and portions of the five pairs of ambulatory appendages, one or more being nearly complete. The sternum forms a rather broad and somewhat triangular area, in front of which the mandibles and the labrum are seen, with the spinous stout basal joints of the long stiff antennæ. There are also traces of the antennules visible.

Each sternite, carrying the thoracic limbs, is ornamented with a pair of rounded, sub-central tubercles, except the first, which has only a single central one.

Upper Cretaceous: Hornby Island; collected by Mr. Robbins, preserved in the Provincial Museum at Victoria, B.C.

Here I would also place a second specimen, preserved in a half nodule, No. 7 (marked 2 in ink), which I refer to *L. Canadensis*. The half nodule measures $6'' \times 4''$, and displays one of the large antennæ and five of the walking-legs very well preserved. The

[1] Added from Dr. Whiteaves' Contrib. Canad. Palæont., vol. i (1885), p. 88.

surface of the appendages is rugose. Three of the body-segments can be seen. Locality: Hornby Island; W. Harvey, 1895.

Although not refigured, it seems desirable, in order to complete this record, to reproduce Dr. Whiteaves' description of this additional Cretaceous form.

"PALÆASTACUS (?) ORNATUS, Whiteaves.

Palæastacus (?) *ornata*, Whiteaves, 1887, Geol. and Nat. Hist. Surv. Can. Ann. Rep., N.S., vol. ii, p. 161 E.

Palæastacus (?) *ornata*, Whiteaves, 1889, Contrib. Canad. Palæont., vol. i, pt. ii, p. 183, pl. xxv, fig. 3.

"The foregoing was suggested as a provisional name for a rather remarkable specimen of a macrouran decapod which evidently belongs to the family *Astacomorpha* of Zittel [1885]. Of Cretaceous representatives of this family it seems to come nearest to such genera as *Palæastacus* and *Hoploparia*, though it differs from each in some important particulars. In many respects it appears to the writer to be still more nearly related to the recent fresh-water genera *Astacus* and *Cambarus*, but there is good reason for supposing that it will eventually prove to be the representative of a new generic type, which at present there is not sufficient material to define satisfactorily.

"Nearly the whole of the under surface of the cephalothorax of the specimen is buried in the matrix, the front margin of the carapace is very imperfect, the caudal plates, as well as the under part of the five abdominal segments, are broken off, and only small portions of the chelæ and of the other ambulatory legs are preserved or exposed.

"The carapace is moderately convex and slightly depressed, and not quite twice as long as broad. It is divided into two nearly equal parts by a single, well-marked, and deeply impressed cervical furrow, which is arched forward in a shallow, concave curve. Behind this furrow the lateral margins of the carapace are slightly expanded, the branchial region is moderately inflated, and the posterior margin is slightly concave in the middle. A short distance in advance of the cervical furrow, on the outer and lower portion of the carapace, on each side, there is a very short and transverse groove or narrow constriction, which may possibly be confluent with the neck-furrow on the strongly curved lateral margins of this part of the carapace. The exact outline of the anterior margin of the carapace cannot be ascertained, and the tip of the rostrum is broken off. The basal portion which remains is about seven or eight millimetres long. At the base it measures 5 mm. in breadth, and at the broken anterior extremity its breadth is 2 mm. Its outer margins are defined by two linear and acute, tuberculated, and raised longitudinal ridges, between which the surface is smooth and concavely excavated.

"The whole of the outer surface of the carapace is ornamented by rather distant, isolated tubercles. In its posterior moiety these tubercles are somewhat irregularly disposed, though there is a low, very narrow, and rather inconspicuous keel on the median line, on

either side of which the cardiac region is comparatively smooth. On the anterior portion of the carapace the tubercles are grouped somewhat obscurely in two or three longitudinal rows on both sides of the narrow median keel, which is continued with greater or less distinctness up to the commencement of the rostrum.

"The anterior chelæ appear to have been short and robust, while their surface is distinctly tuberculated. The portions of the posterior ambulatory legs that happen to be preserved, on the other hand, are very slender, and their surface is minutely granulated. The abdominal segments are badly preserved, but their outer surface seems to have been smooth, though a narrow median keel can be traced throughout the greater part of their dorsal surface.

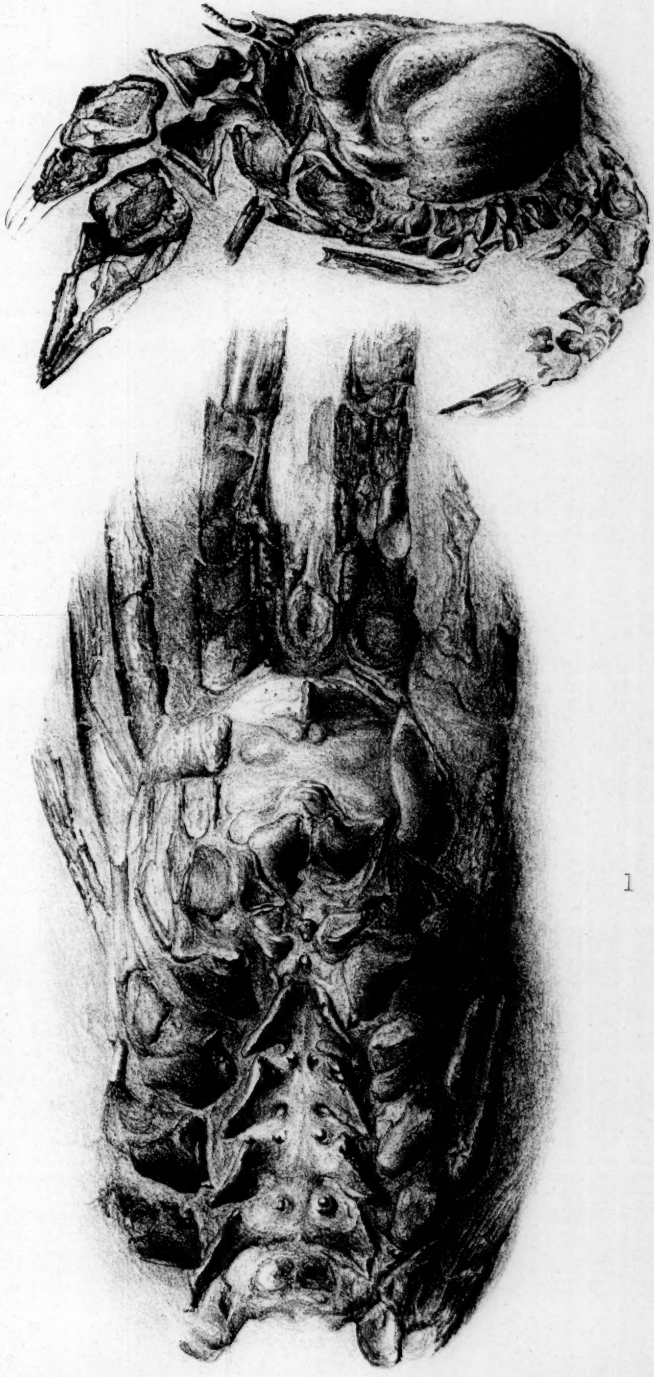
"Locality: Sounding Creek, Township 30, Range 8; west of the 4th Principal Meridian, 1886.

"At the same locality and date, five detached chelæ, apparently of a second species of decapod Crustacean, were collected in as many concretionary nodules. These claws resemble those of *P. ornatus* in the comparative shortness and robustness of their terminal segments, but the outer surface of the latter is finely granulated rather than coarsely tuberculated."

ERYMA DAWSONI, H. Woodw., sp. nov. (Pl. XVI, Fig. 2.)

Among the specimens which form a second collection sent by Dr. J. F. Whiteaves (24th September, 1898) from the Geological Survey of Canada, is the half of a nodule containing an Astacidean from the Upper Cretaceous of the north-east side of Hornby Island, British Columbia, collected by Mr. J. B. Bennett in 1898 (No. 55D).

The Crustacean is seen in profile on the split surface of a nodule, and exhibits the cephalothorax, with its stout pair of chelate limbs (or forceps) attached, and the remains of the four pairs of succeeding ambulatory legs, the six abdominal somites, and the telson, but the lateral lobe of the tail-fin was probably preserved in the other half of the nodule not sent. The branchiostegite (covering the branchiæ) is broad and tumid, and the branchiocardiac groove is strongly marked. Starting from the median dorsal line as a V-shaped furrow, about 12 millimetres from the posterior border, it bends rapidly forward, becoming deeper on each side, and reaches the lateral border 24 mm. in advance; here it unites, close to the hepatic lobe, with the equally deep but more transverse cervical furrow, which crosses the carapace 10 mm. nearer to the front. In advance of the cervical groove the postorbital ridge and spine can be seen, also the base of one of the antennules, with part of one of its flagella, beneath the somewhat short rostrum, and lower down the base of one of the outer and larger antennæ. The surface of the branchiostegite is marked by numerous small tubercles scattered irregularly over the surface. The branchial, cardiac, and hepatic regions are also similarly tuberculated, and very tumid. Length of carapace 48 mm., depth of side 25 mm. The ambulatory limbs are fairly long and slender; the chelate limbs measure about 60 mm. in length; length of penultimate



2

1

G.M. Woodward & H.B. Potter. West, Newman imp.

Decapod Crustaceans
U. Cretaceous Comox & Hornby Id. B.C.

joint 35 mm., breadth 15 mm., length of ultimate joint 20 mm. The fingers are long and slender, the inner edge of the forceps being denticulated; wrist 6 mm. long by 10 mm. broad. The epimeral border of each abdominal segment is falcate in contour.

The general form and details of this Crustacean, so far as preserved, clearly mark its place among the Astacidea, or under the Astacomorpha (as defined by Huxley, 1881), and I would suggest that Oppel's name of *Eryma* is appropriate for it, seeing that it agrees very closely in the divisions of its carapace and its tuberculated surface, in the antennæ, the form of the first pair of forcipated chelæ, and the proportions of its abdomen, with *E. Perroni* and other Jurassic species.

Oppel observes[1] that no examples of the genus *Eryma* have been found in rocks younger than the Jurassic, and that the Astacidæ of the Chalk are placed in McCoy's genera *Hoploparia* and *Enoploclytia*, but in this instance the form in question agrees much more closely with Oppel's genus *Eryma* than with other forms. I therefore propose to relegate it to that genus, and to designate it by the specific name of *Dawsoni*, in honour of Dr. G. M. Dawson, C.B., F.R.S., the eminent Director of the Geological Survey of Canada, who has done such splendid work in the field in mapping the geology of British Columbia.

EXPLANATION OF PLATES XV AND XVI.

(All from the Upper Cretaceous formation, and drawn of the natural size.)

PLATE XV.

FIG. 1. *Linuparus Vancouverensis*, Whiteaves. Dorsal aspect of cephalothorax, showing some of the ambulatory legs. Puntledge or Comox River, Vancouver Island, British Columbia.

,, 2. *Linuparus Vancouverensis*. Hornby Island. Shows cephalothorax and abdomen united and smaller walking limbs.

,, 3. *Linuparus Vancouverensis*. Comox River. Shows inner surface of thorax, with the mandibles (*m.*) and the walking-legs; also bases of the antennules and upper surface of abdominal somites.

PLATE XVI.

FIG. 1. *Linuparus Canadensis*, Whiteaves. Under side of cephalothorax.

,, 2. *Eryma Dawsoni*, H. Woodw. Hornby Island. Specimen imbedded in a nodule seen in profile. Geological Survey Museum, Ottawa.

(*To be continued.*)

III.—FOSSIL MAMMALIA FROM EGYPT. Part II.

By CHAS. W. ANDREWS, D.Sc., F.G.S., British Museum (Nat. Hist.).

IN addition to the remains of the large Anthracotheroid (*Brachyodus africanus*) described in the first part of this paper (GEOL. MAG., Dec. IV, Vol. VI, 1899, p. 481), the collection of mammalian bones from the Lower Miocene of Moghara also includes portions of the skeleton of a small rhinoceros. Unfortunately this is very poorly represented, there being only an incomplete scapula and an atlas vertebra, and in the absence of any portion of the skull or teeth it is impossible to determine the species to which it may have belonged. As was pointed out in Part I, the age of the deposit is Burdigalien (Lowest Miocene), and it is therefore contemporary with the Sables de l'Orléanais and the fresh-water deposits of

[1] Palaeontol. Mittheilung., 1862, p. 22.

Eggenburg. From the latter no rhinoceros remains are recorded, but from the former several species seem to have been obtained. Of these only one, *Aceratherium aurelianense*, has been described and figured.[1] Gervais, on the authority of the Abbé Bourgeois,[2] has given a list of five species from the Sables de l'Orléanais, but none of these seem to be true Burdigalien forms, some being Middle Miocene, others Upper Oligocene. More recently Mermier[3] has described and figured a fine skull and mandible of an *Aceratherium* from the Burdigalien of Pont-de-Manne in Royans (Drôme), South-Eastern France. Of this species, to which the name *A. platyodon* has been given, nothing beyond the skull and mandible has been described and figured, so that it is not possible to compare the Egyptian specimens with it. Not improbably, when further remains are obtained from Moghara it will be found that this Egyptian rhinoceros is identical with *A. platyodon*, *A. aurelianense*, or with one of the other species which actually occur in the Sables de l'Orléanais, but seem to have been so far confused with forms from other horizons. The extreme hardness and generally good state of preservation of the Egyptian bones render it highly probable that excavations at Moghara would yield very complete and valuable specimens, and it is to be hoped that such a systematic search may sooner or later be made.

The *atlas* is somewhat smaller than that of any recent rhinoceros, but at the same time it is relatively longer; moreover, the cups for the occipital condyles are much deeper and are separated by a deeper notch, and the surfaces for articulation with the centrum of the axis are inclined to one another at a more acute angle than in any rhinoceros atlas with which I have been able to compare it. The transverse processes are much broken at their extremities, which seem to have been expanded to a considerable degree; near their bases they are perforated by a very oblique vertebrarterial canal, the ventral opening of which is near their middle point, the dorsal near their anterior border just external to the outer angle of the articular surface for the axis. A similar canal is seen in the atlas of some specimens of *R. bicornis*, but is absent in others, so that it cannot be regarded as a character of much importance. The neural arch is narrow from before back, and is perforated by a large foramen for the first spinal nerve; the impressions of the nuchal ligament are not strongly marked, probably indicating that compared with that of the recent horned rhinoceroses the skull was light.

The only atlas vertebra of any of the older forms of rhinoceros with which I have been able to compare this specimen is that of *R. schleirmacheri*, described and figured by Kaup, and of which there is a cast in the British Museum. From this atlas our specimen differs as widely and in the same points as from those of recent forms.

[1] Nouel, "Mémoire sur un nouveau Rhinocéros fossile," pls. i–v: Mém. de la Société d'agriculture, sciences, belles-lettres, et arts d'Orleans, viii, 1866, p. 241.

[2] Gervais: "Zool. et Pal. générales," ser. i (1867–9), p. 157.

[3] Mermier, "Sur la découverte d'une nouvelle espèce d'*Acerotherium*": Ann. Soc. Linn. Lyon., tom. xlii (1895), p. 163. Also, op. cit., tom. xliii (1896), pp. 225 and 257.

The dimensions of the atlas are:

	mm.
Greatest width across articulation for skull	140
Greatest width across articulation for axis	153
Antero-posterior width of base of the transverse process	94
Height of neural canal	70
Width of neural canal	62

In the imperfect right scapula, probably belonging to the same species, the supra-scapular border, the upper edge of the spine, and the upper portion of the glenoidal border have been broken away. The most notable points about this bone are: (1) the straightness of the coracoid border, which for the greater part of its length is parallel to the base of the spine; and (2) the comparative narrowness of the prescapular fossa. In both these points the fossil scapula resembles that of *R. bicornis* more nearly than those of other living species, but its coracoid border is still straighter and the spine is less inclined backward than in that species. In *R. unicornis* the width of the bone above the coracoid tuberosity is relatively considerably greater, the coracoid border more convex, and the prescapular fossa somewhat wider than in the fossil; but on the other hand, in the general backward curvature of the blade there is considerable similarity in the two forms. The scapula of *R. sondaicus* is widely different, being much more expanded and having a strongly convex coracoid border. In *R. simus* also the coracoid border is convex, the prescapular fossa wider, and the coracoid tuberosity much more massive. Another point which distinguishes this scapula from those of recent types is the form of the glenoid articulation, which is ovate, with the narrow end towards the coracoid border; in recent forms this surface is nearly circular, although in *R. indicus* there is some indication of an ovate form.

Comparison with fossil forms is difficult, owing to the fact that the scapula is seldom figured, and that there are scarcely any specimens in the Natural History Museum. Amongst the scapulæ of which figures are available our fossil seems to approach most nearly to that of *R. pachygnathus*, from the Upper Miocene of Pikermi, figured in Gaudry's "Animaux fossiles et Géologie de l'Attique," pl. xxxi, and from this it differs in much the same points as from the scapula of *R. bicornis*.

The scapula is too incomplete to give any accurate measurements, but its approximate dimensions are as follows:—

	mm.
Glenoid surface, long diameter	77
Glenoid surface, short diameter...	62
Width immediately above coracoid tuberosity	95
Approximate length	360

As was remarked above, the remains here noticed are far too incomplete and the material for comparison too scanty, for it to be possible to say more than that the bones are those of a rhinoceros; but at the same time the general similarity of the scapula to that of *R. bicornis* and *R. pachygnathus* suggests the probability that this Miocene type will prove to belong to the same series of which those species are members.

IV.—On the Constituents of the Sands and Loams of the Plateau Gravel occurring in the Pit Sections near Ash, Sevenoaks.

By Frederick Chapman, A.L.S., F.R.M.S.

I AM indebted to the Rev. Ashington Bullen, B.A. (London), F.G.S., for eight samples of sands and loams from the Plateau Gravel of Kent, which he has placed in my hands for examination with the microscope. They were carefully collected by Mr. B. Harrison, of Ightham; and for convenience they are here lettered A–H.

The sections of these and other pits, made under a grant from the British Association in 1895, are published in the Report of the British Association for that year.

A.—A greyish or mottled clay, at 3 ft. 6 in. The proportion of argillaceous material washed from this sample was 73 per cent., leaving a residuum of 27 per cent. of fine and coarse sand. The sandy residue consists of very fine angular quartz and pale glauconitic fragments. There is also a large proportion of accreted sand-grains, some of which simulate rhizopodal tests, if they are not actually such, and resemble genera which affect sandy and shallow marine areas.

B.—A pebbly loam, from Pit No. 2, at 3 ft. 6 in. ("Ash, 1896"). A large proportion of this material consists of well-rounded pebbles of flint, with an occasional subangular fragment. The sandy residue after washing is seen to be composed of angular chips of flint and quartz, with some ferruginous matter.

C.—A grey sandy loam from Pit No. 1, at 5 feet. This material is excessively fine. After the finest sand and clay was removed by washing, the residuum amounted to 45 per cent. A part of the washings was treated for heavy minerals, of which there is a noticeable quantity. The average size of these mineral particles is about ·05 mm. in diameter. They consist of (1) *Hornblende*, a few fragments, some with a decided blue tint suggestive of Riebeckite; (2) *Chlorite*, several flakes; (3) *Tourmaline*, numerous and in very perfect crystals grey to greenish-brown; (4) *Kyanite*, a few flakes; (5) *Glauconite*, numerous rounded granules; (6) *Zircon*, exceedingly common, some well-formed crystals with prism of 1st order and pyramids of 2nd order; also badly developed crystals with rounded angles, good examples of zoning, cavities, and inclusions; (7) *Rutile*, many examples, including both short and long prisms, of a fine red-brown colour. The above-mentioned minerals are much smaller than any others I have met with, either in the Bagshot Sands or the Lower Greensands, but in many respects are like those from the first-named deposits. The quartz grains are very minute and perfectly angular. There are also a few cherty and accreted fragments present.

D.—A pebbly loam, from Pit No. 2, at 8 feet. Somewhat similar to the preceding; with a difference in the character of the pebbles, which, although rounded, are split apparently by frost action. The

fine sand is interesting on account of its diverse nature, consisting chiefly of angular fragments of quartz, with numerous subangular and partially rounded quartz and flint grains, and very rarely a probably wind-polished grain of quartz. A sponge-spicule was noticed in this sample.

E.—An umber-coloured clay, from Pit No. 2, at 8 feet. This specimen yielded a residuum, on washing away the fine argillaceous portion, of 42 per cent. This consists of fine angular quartz sand, and a smaller proportion of accreted particles, of an umber-brown colour.

F.—A bright ochreous yellow sandy rock, of fine texture, from Pit No. 2, at 8 feet. The fine argillaceous and ochreous portions of this rock were separated by decanting after stirring and allowing the washings to settle for 20 seconds. This gave a residuum of 72 per cent. The fine portion consists of minute grains of quartz, very angular, and associated with them were some flakes of limonitic material. A small proportion of the residue is much coarser and floats easily. It consists of tubular and reticulose or pitted fragments of a purple-brown colour, somewhat of the nature of 'race.' The reticulate surface may possibly be due to the impress of sand-grains. Some of the particles in this residue have a chalky appearance, and are doubtfully comparable with worn specimens of foraminifera; there are also a few fragmentary sponge-spicules. The rarer minerals are also present in some abundance in this sand, such as zircon, tourmaline, rutile, and kyanite.

G.—A pale ochreous sandy clay, from Pit No. 2, at 8 ft. 2 in. The residuum after washing was 40 per cent. The chief part of the sand consists of angular and subangular quartz grains, with a smaller quantity of flinty particles, and with a few larger accreted fragments of a dark umber colour. Some of the large quartz grains show evidence of wind-polishing.

H.—Sand with iron-oxide cemented to an eolith, from a pit at Ash in the gravel that occurs at 8 feet. The separated sand-grains carry a more or less thick covering of ferruginous cement. The finer sand-grains consist of sharply angular quartz fragments; the larger grains are angular, subangular, and rounded, or even highly polished, fragments of quartz, chert, and flint. Several of the particles noticed are of foraminiferal origin, consisting of pale glauconite. One very perfect cast, in apple-green glauconite, was here noticed, and identified as that of *Globigerina cretacea*, D'Orb.

Relics of minute marine fossils (some certainly from the Chalk) occur in the samples of loams and sands, D, F, and H. The sand-grains of flint, chert, glauconite, and quartz are referable, of course, to the Chalk, Greensands, and to some more ancient rocks, and may have passed through several stages of erosion and sedimentation before their deposition in these gravel-beds. The presence of the rarer 'heavy minerals' indicates very much older rocks as their real source; but they probably formed part of other beds in succession, as, for instance, in the Bagshot Sands, to which allusion is made in

the note on B. Indeed, it has occurred to me that the brown clay-seam on the top of the Raised Beach at Aldrington, near Brighton, and which contains so many 'heavy minerals' in the residue,[1] has been derived, similarly to the plateau drift here described, from an older bed common to both areas.

V.—Palæolithic Flint Implements from the Chalk Downs of the Isle of Wight and the Valleys of the Rivers Western Yar and Stour.

By S. Hazzledine Warren, F.G.S.

IN taking my first walk over West High Down, near Freshwater Bay, in May of last year, I found that the ground had been ploughed up by traction engines drawing heavy guns to some new forts on the Needles Point, then in course of construction. Thinking that there might be some Neolithic implements turned up, I examined the ruts, when almost the first thing I saw was a Palæolithic implement. It was ovate in form, $3\frac{1}{4}$ inches long by $2\frac{3}{8}$ inches broad, thin, very slightly twisted, well made and symmetrical though not elaborately finished, and ochreous and almost unabraded in condition. So far as I am aware, this is the first Palæolithic implement that has been found in the district.[2]

Not a single stone had been thrown down to make a road, and from the first I felt sure that it had been turned up on the spot. The following day I took a trowel with me, and discovered that there was a drift of stony clay; in this I found a Palæolithic core at a depth of 19 inches from the surface, though the width of my hole at that depth was scarcely larger than the size of the core.

Through a mutual friend I obtained the consent of the owner of the land, Mr. Granville Ward, of Weston Manor, Totland, and Northwood, Cowes, to dig further. The following sections will show the general character of the deposit.

Hole A, about 35 yards north of where the first implement was found, and at a slightly lower level.

	feet	inches.
4. Surface soil	1	0
3. Loam, with stones similar to those in the layer below ...	0	6–9
2. Layer of stones: composed of flint nodules; fractured, unabraded, whitened flints; fractured, red-stained, scratched, and brown abraded flints; Tertiary flint pebbles and ironstone; and Palæolithic implements ...	0	3
[1a. In places, over an area of from 1 to 3 square feet, the stained and scratched flints were found in the yellow clay below the layer of stones. Here implements were most abundant, the flakes sometimes almost touching each other.]		
1. Yellow clay, with yellowish white, or grey, fractured, unabraded flints, and some Tertiary flint pebbles and ironstone ... ... Seen to	1	9
	3	6

[1] Proc. Geol. Assoc., vol. xvi (1900), p. 266.

[2] For an account of the discoveries at the other extremity of the island, see T. Codrington, Quart. Journ. Geol. Soc., vol. xxvi (1870), p. 542; and Sir John Evans, "Ancient Stone Implements of Great Britain," 2nd ed. (1897), p. 626.

Hole B, very near where the first implement was found.

	feet	inches.
4. Surface soil	0	8
3. Layer of stones: composed of whitened, unabraded flint fragments; Tertiary flint pebbles and ironstone; some ochreous flint fragments; and Palæolithic implements	0	2–4
2. Yellow clay: full of small, yellowish-white, unabraded fragments of flint; flint nodules; a good many Tertiary pebbles; and some ironstone ... ... 1 ft. 3 in. to	1	10
1. Rolled chalk rubble, with a very uneven surface Seen to 2 ft. 4 in. to	1	9
	4	6

Between these two sections I found—

	feet	inches.
5. Surface soil	0	8
4. Layer of stones, as in hole B	0	2
3. Loam, as in hole A	0	9
2. Layer of stones, as in hole A	0	3
1. Yellow clay, as in holes A and B	touched	
	1	10

It is thus seen that the lower layer of stones and the loam above disappear just beyond where the upper layer of stones comes on. I have traced this upper layer for a distance of 80 or 100 yards to the south, while at some 70 yards beyond this point I found stony clay, with no definite stratification, to a depth of 2 ft. 6 in.; how much deeper it may be I do not know. The lower layer of stones I found to preserve its character over an area of more than 100 square yards, with no sign of its termination to the north or west.

The implements are generally abraded, sometimes only very slightly, but often to a considerable extent. Many of them are much altered and corroded, and rough and unpleasant to the touch. These are stained either of a dirty reddish-brown or yellow colour, and are often very blotchy in appearance. But in and above the lower layer of stones (bed 2 of hole A) many of them, though abraded on the edges, are not so altered; some of these are stained of a fairly rich red, but a larger number are nearly of their original colour. It is not improbable that these may belong to a later phase of the Palæolithic period than the corroded forms, but my collection is not large enough to warrant a definite conclusion on the matter. The Stoke Newington district, so admirably worked out by Mr. Worthington Smith, affords an excellent standard of comparison for three phases of the Palæolithic period. I have a considerable collection from that district, and the corroded implements from High Down certainly suggest a parallelism with the oldest of Stoke Newington; while the non-corroded examples suggest the latest or Le Moustier phase rather than the intermediate or River Drift proper, though no definite Le Moustier types have been found by me on High Down. One of those from the lower layer of stones on High Down, a pointed implement, 5 inches long by 2 inches broad, and possessing the peculiarity of being triangular in section,

is similar in type to one of the Le Moustier period of Stoke Newington in my collection. Both owe their form, in great part, to the natural fracture of the flint, and are merely trimmed to a serviceable shape by a small number of blows.

The original ovate implement that I first found came from the upper layer of stones, and, like several others (flakes and cores) from that level, it is stained of a yellow colour, though not deeply altered, and practically unabraded; but one, a straight-edged scraper, belongs to the corroded series, and its surfaces are covered with the characteristic scratches. From bed 1A of hole A I have an excellent core, $3\frac{1}{2}$ inches long by $2\frac{1}{4}$ inches wide, showing three straight parallel facets, flaked with a skill that is rarely seen among earlier Palæolithic finds.

The corroded examples, like the earlier Palæolithic implements from Stoke Newington and elsewhere, nearly always bear evidence of having been twice abraded: once before, and again after, they received their ochreous patina; showing them to have been derived from an earlier drift.

The greatest depth at which I have dug an implement in the High Down drift is 3 ft. 6 in.; I have several from about 3 feet, but the greater number are from 1 ft. 6 in. to 2 feet.

The position in which this drift occurs is interesting and suggestive. The range of the chalk downs is breached down to sea-level at Freshwater Bay by the former course of the Western Yar. From this point westward the downs rise steadily to 483 feet above Ordnance Datum at the summit of East High Down, on which eminence the Tennyson memorial cross has been erected. From this point the ridge of the downs falls steeply to 361 feet O.D., and thence rises gradually to 462 feet O.D., the summit of West High Down, not far from the Needles Point. It is in the low part, between East and West High Down, that the Palæolithic drift occurs. So far as I can make out, the actual lowest point is 361 feet O.D.; but there is little or no drift here. The main mass of it occurs at from 75 to 150 yards to the west of the lowest point, and at a level of perhaps 4 or 5 feet above it. This spot I shall for convenience refer to as "the drift area."

This drift area extends only for about 75 yards from east to west, or along the ridge of the downs, but I have traced it for a much greater distance, both southward towards the sea and also northward down the steep dip slope of the chalk on to the ridge across the Eocene valley presently to be mentioned.

Opposite the drift area on the chalk downs is Headon Hill, 397 feet in height, formed of Oligocene strata capped by 30 feet of drift gravel. Between Headon Hill, the highest ground on the Tertiary area, and the drift area, there is a ridge across the intervening Eocene valley at about 270 to 280* feet[1] O.D. This ridge forms a water-parting between the stream flowing westward into Alum Bay and that flowing north-eastward into Totland Bay.

[1] The levels for this district are not published by the Ordnance Survey. Those with an asterisk are approximate aneroid levels taken by myself.

As already mentioned, the implementiferous clay drift extends down from the chalk downs on to this ridge, and I have found a number of rude, ochreous, and much abraded Palæolithic implements on a ploughed field here.

There can be little doubt that the gap in the chalk downs with its Palæolithic drift, the ridge across the Eocene valley, and the large mass of gravel capping Headon Hill, are closely connected with each other in their origin. The Headon Hill gravel is stratified in irregular, confused masses; it is composed of flint nodules, often more or less battered and rolled on their projecting branches, fractured fragments of flint that are practically unabraded, together with a certain number of flint pebbles derived from the Tertiary beds, but no débris from strata below the chalk nor any foreign erratics. Headon Hill is now quite isolated, with the exception of the ridge at about 270° feet O.D. that connects it with the chalk downs, so that the gravel capping it is evidently a very early drift, possibly Pliocene, but certainly long anterior to the Palæolithic drift on High Down. It appears to me to be a terrestrial and not a marine deposit; and to have been swept down along the line of the col, if I may so term it, that now forms the gap between East and West High Down, at a time when the chalk range was several hundred feet higher than it is now.

It seems to me that this is the simple and natural explanation of the Headon Hill gravel; but I find a greater difficulty in explaining the Palæolithic drift on the downs. I at first thought that it belonged to a stream flowing northward into the old Solent River from land to the south that had since been destroyed by the sea. But there are various objections to this view. Firstly, the surface of the downs slopes southward from the drift area at about 365° feet O.D. down to about 290° feet O.D., where it is cut off by the present sea-cliff; and has apparently continued to slope downwards to a still lower level before the sea had encroached to its present position. So that from the contours of the downs the difficulty of a stream flowing from the south is quite as great as that of one flowing from the north (or north-west), and from other considerations far greater. Secondly, the very abundant remains of Tertiary strata, in the shape of flint pebbles and ironstone, that are found in the drift, would necessitate the supposition of Tertiary outliers to the south, if it had come from that direction, which a glance at the geological structure of the district shows one to be an unjustifiable assumption; without going back to a time long anterior to the Palæolithic drift. Supposing the drift to have come from the north or north-west, the difficulty is only one of some 90° feet, that is, the difference between the ridge of the Eocene valley and the level of the drift. And as the ridge is being cut back on both sides by the streams flowing westwards into Alum Bay and north-eastwards into Totland Bay, the difficulty is not a great one. Further, it appears to me that not only Alum Bay Chine itself, but the whole valley from the ridge westwards, which is only $\frac{2}{3}$ mile long, is comparatively modern; that it was formerly occupied by Tertiary beds, and that the drainage flowed

eastwards and then north-eastwards through what is now Totland Bay into the old Solent River. At the time the Headon Hill gravel was deposited, at least, it is manifest that this valley could have had no existence, but that the base-level of the Headon Hill gravel at 360 to 370 feet O.D. was then the lowest ground at the foot of the chalk range, flanked by Tertiary beds. The great mass of this gravel would resist the forces of erosion much more powerfully than the soft Eocene sands, and thus gradually become isolated by the cutting away of those strata. If this view be correct, the Palæolithic drift on High Down belongs originally to an early stage in the formation of the Eocene valley, though it has, in part, been re-drifted at various later times.

I have also found Palæolithic implements in the gravels of the Western Yar. In Pleistocene times this river flowed about a mile to the south of Brightstone and Brook, then over what is now Compton Bay, and through the gap in the Chalk downs at Freshwater Bay, to join the old Solent River near Yarmouth. The Pleistocene gravels, with their accompanying brickearth, seen along the cliff section from Brightstone Grange Chine to Compton Bay, occur in terraces at from 60 to 120 feet O.D. The highest terrace is called 'Plateau Gravel' by the Geological Survey, but I cannot agree with thus giving it a separate title, especially as it has little in common with those drift deposits that usually go by that name. I have not been successful in finding any implements along the cliff here, but I think if they were carefully watched as falls take place from time to time, that implements would very probably be found in them, perhaps most abundantly in the upper terrace.

On the other side of Freshwater Gate I have found Palæolithic implements in a patch of gravel, not marked on the Survey Map, that caps an isolated knoll at about 95* feet O.D. It is evidently a remnant of a river terrace that has been almost entirely destroyed by denudation. Nearer Freshwater Church there is another knoll which forms the highest ground for some distance round. This is also capped by gravel, though not so coloured on the Survey Map. The elevation of this knoll is about 10 or 15* feet below the level of the other patch; but as the thickness of the gravel here appears to be only 4 or 5 feet, whereas the thickness in the other knoll is 10 feet or more, the level of the two very closely corresponds, and they are evidently remnants of the same terrace. There are also terraces at lower levels about Freshwater, but I have not at present succeeded in finding any implements on them.

Both the gravels of the cliffs near Brook and Brightstone, and also those of Freshwater, contain occasional pebbles of Palæozoic rocks. These, I think, have most probably been derived from Lower Cretaceous strata. In the gravels on the left bank of the old Solent River about Bournemouth erratics are far more numerous; and they have doubtless been derived from the west, as maintained by Mr. A. E. Salter.[1] In going over the gravels of that district

[1] Proc. Geol. Assoc., vol. xv (1898), p. 277; see also R. Godwin-Austen, Quart. Journ. Geol. Soc., vol. xiii (1857), p. 45.

I noticed in the Plateau Gravels from Canford Heath to beyond Talbot Village, and also on the isolated St. Catherine's Hill[1] near Christchurch, that erratic pebbles are very abundant, though flint forms the bulk of the gravel so far as the larger stones are concerned; but with the coarse grit (pieces of from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter) a large proportion of its bulk is composed of those erratics. The same is the case with the gravels already mentioned belonging to the old Solent River that are exposed in the cliffs from Branksome to Southbourne, and in many pits about Bournemouth. But as soon as one crosses the ridge, capped by Plateau Gravel, into the valley of the Stour, one finds that the bulk of the grit is composed of flint with some quartz; indeed, I looked a long time before I found a single erratic in the grit, though I had found one or two of larger size. This was surprising to me, as I had previously thought that the lower terrace gravels were formed out of the materials of those at a higher level, merely relaid at a lower level as the excavation of the valley proceeded. But this is evidently not the case in this instance. One sees from the great difference in the composition of the grit that the gravels of Moordown and Winton, in the Stour valley, are quite independent in their origin of those of Canford Heath, from which one would naturally have imagined them to have been derived.

About Moordown there is a very well developed terrace at 70 or 80 feet above the River Stour, in which I have obtained a number of Palæolithic implements, both pointed and ovate. One is of a rather rare type, with an almost adze-like cutting edge, $1\frac{5}{8}$ inches wide, the whole blade being 6 inches long by $3\frac{1}{4}$ inches wide. I am not aware that Palæolithic implements have previously been recorded from this locality. Indeed, Sir John Evans, in the last edition of his "Ancient Stone Implements of Great Britain" (1897, p. 634), says: "In the basin of the Stour, which joins the Avon at Christchurch, but one discovery has been made." This, he proceeds to say, was in gravel dug near Wimborne Minster, but not *in situ*. In the gravel of Little Down Common I also found a flake, though I visited the pit but once, and then for a short time only; I have no doubt that a more extended search would be fully rewarded. This gravel also belongs to the valley of the Stour, and the grit is wanting in erratics.

From the gravels of the Western Yar about Freshwater, I have obtained a number of much abraded brown flints, with battered edges, resembling the so-called 'Eolithic' implements from the chalk downs of Kent. I feel no little hesitation in attributing the majority of these to human agency. Both from Freshwater and elsewhere, I have Eolithic types (whether they be implements or not), the chippings upon which are contemporary with the River Drift series proper, that is, later than the earlier Palæolithic forms.[2]

[1] There is danger in visiting the pits on the summit of this hill, owing to the proximity of the rifle-butts, and there is nothing to warn one. I narrowly escaped being shot here in February last.

[2] I have some in which the chippings are contemporary with Neolithic implements.

So that the finding of a few Eolithic types, even supposing them to be truly worked by man, would not, apart from other evidence, prove any great antiquity. A certain number of undoubted implements, similar to the (derived) earlier Palæolithic types of the river gravels, have certainly been found in the high-level drift of Kent. I at first hoped that some light might be thrown on the question of Eolithic man by the drift on High Down; but I have, at present at least, no evidence to offer bearing very directly on this problem.

NOTICES OF MEMOIRS.

SHERBORN'S INDEX ANIMALIUM.—Report of a Committee, consisting of Dr. H. WOODWARD (Chairman), Mr. P. L. SCLATER, the Rev. T. R. R. STEBBING, Mr. R. MCLACHLAN, Mr. W. E. HOYLE, and Mr. F. A. BATHER (Secretary), appointed to superintend the Compilation of an Index Animalium.

THE examination of the literature published from 1758 to 1800 inclusive has been continued by Mr. C. Davies Sherborn, to whom facilities have, as heretofore, been granted by the authorities at the British Museum (Natural History). Between July, 1898, and June, 1899, he has seen and indexed 1,528 volumes and tracts, and has now reduced the list of desiderata to about 500 items. Of these scarcely 100 are likely to be of any importance to the systematic zoologist; but every effort will be made to consult them, so as to be certain that everything has been recorded.

The Committee desires to express its grateful thanks for the loan of rare and valuable books, and for information concerning them, to the following:—The Hof-naturalien Kabinet of Vienna, Dr. Eduard Suess, and Dr. Steindachner; Dr. F. A. Jentink, of Leyden; Akademiker F. Schmidt, of St. Petersburg; the Stadt-Bibliothek of Zürich, Dr. Eschner, and Professor Renevier; the Hon. Walter Rothschild and Mr. Hartert; Sir Edmund Loder; Mr. Du Cane Godman and the late Mr. O. Salvin; Lord Walsingham and Mr. J. H. Durrant; Professor Amalitzky, of Warsaw; Prof. Anton Fritsch and Dr. Jan Perner, of Prague; Professor Alfred Newton; Mr. W. E. de Winton; Mr. Gerrit S. Miller, of Washington; Mr. A. C. Seward, of Cambridge; and Prof. H. A. Miers, of Oxford. Dr. Philippe Dautzenberg, of Paris, has also greatly aided the compiler in his efforts to obtain the loan of a rare catalogue. The editors of "Nature" and "La Feuille des jeunes Naturalistes" have lent valuable aid in publishing lists of desiderata. Of the generosity of the Vienna Kabinet, the Zürich Library, and Dr. Jentink, all of whom have sent over their treasures for inspection, the Committee cannot speak too highly.

Again the special and hearty thanks of the Committee are due to the Zoological Society of London for pecuniary assistance, which will, as in the past, greatly facilitate the work of procuring access to this rare literature.

The reference slips themselves are now in alphabetical order, and the work of checking previous reference books and of eliminating duplicate entries will be proceeded with as quickly as possible.

The following reports on dates of publication of various books have been published by Mr. Sherborn during the year:—

De Blainville, "Ostéographie": Annals and Mag. Nat. Hist. (7), ii, 1898.

Hübner, "Samml. europäischer Schmetterlingen": Annals and Mag. Nat. Hist. (7), ii, 1898.

C. d'Orbigny, "Dictionnaire Universel": Annals and Mag. Nat. Hist. (7), iii, April, 1899.

Humboldt & Bonpland, "Obs. de Zoologie": Annals and Mag. Nat. Hist. (7), iii, 1899.

Lichtenstein, "Catalogus rerum naturalium": Annals and Mag. Nat. Hist. (7), iii, 1899.

"The Dates of the Paléontologie Française": Geol. Mag., 1899, pp. 223–225.

Temminck & Laugier, "Planches coloriées": Ibis, Oct., 1898.

It may also be mentioned that Mr. Sherborn has prepared an "Index to the generic and trivial names of animals described by Linnæus in the 10th and 12th editions of the *Systema Naturæ*," and the thanks of zoologists are due to the Manchester Museum, Owens College, for issuing this through Messrs. Dulau & Co., London, as its "Publication 25."

In the full belief that the first section of the Index (1758–1800) will soon be ready for publication as a tangible result of the compiler's labours, the Committee earnestly recommends its reappointment.

REVIEWS.

I.—The Scientific Study of Scenery. By J. E. Marr, M.A., F.R.S. 8vo; pp. 368. (London: Methuen & Co., 1900. Price 6*s*.)

NOT long ago we had the pleasure of noticing Mr. Marr's admirable introduction to "The Principles of Stratigraphical Geology," and now students of the physical side of that science are to be congratulated on a further contribution in book form from the same pen.

The volume is described in the Preface as "An introductory treatise on Geomorphology, a subject which has sprung from the union of geology and geography." It is a terrible word to hurl at the head of the unoffending general reader, whose interest in the subject the book is intended to arouse, and we fear that some readers will be so disheartened at the outset that they will lay down the book before reading the first chapter. Fortunately most people avoid the preface (we do so ourselves) and begin by looking at the illustrations, in which case the reader is sure to get interested and the author will be saved. Unfortunately 'physiology' (the

obvious portmanteau word for physical geology) has already been annexed, and the meaning of the term 'physiography' has apparently expanded indefinitely, like the atmosphere, losing in attraction as it departs further and further from any 'solid ground.' But surely some more popular term might be found for the science of scenery.

After a brief introduction on the attributes of scenery, the author proceeds to discuss the nature of the earth's exterior, which he considers under the heads of Atmosphere, Hydrosphere, and Lithosphere; the greater part of chapter ii being taken up with the description of the mode of origin of the rocks composing the Lithosphere, and the changes they have subsequently undergone in position and structure.

In chapter iii we have a short essay on the production of dominant forms due to accumulation, elevation, depression, and sculpture, and the similarity in form assumed by the Atmosphere, Hydrosphere, and Lithosphere is strongly emphasized; we think, however, that the parallel instituted between the formation of cloud, sea, and earth-waves is open to misconception, and that the student might very easily close the book with the idea that the form of the earth-waves was originated by meteoric agents, as in the case of clouds and sea-waves, when he reads on p. 24, "similarly the earth-waves are carved out by the graving tools of nature, and the effects are generally similar to those produced on ocean-waves by the wind."

Chapter iv deals with the atmosphere, but is practically taken up with a description of the form and mode of origin of clouds. It is difficult, no doubt, in treating of a subject like Scenery for the author to decide exactly how much to take the reader into his confidence regarding the causes which produce the visible effective scenery, and we think that compared with the rest of the subjects dealt with in the book, the atmosphere has a distinct grievance with regard to the space allotted to it, though the description of the various forms of clouds is unusually clear and full.

In chapter v we have a description of the continents and ocean basins. In the consideration of their main features the author adopts Professor Lapworth's very suggestive views as propounded in his remarkable address to Section C at the Edinburgh Meeting of the British Association. If the exigencies of space permitted we should like to see the subject of this chapter dealt with at somewhat greater length. We have, for instance, no allusion to the Hemihedral Tetrahedral theory (of Lowthian Green, 1875, and J. W. Gregory, 1899), which alone attempts to account for the curious wedge-like termination of the continents to the south.

The three following chapters are devoted to the origin and structure of mountains, the first being confined to mountains of upheaval, among which the 'Laccolite' of Gilbert and the Alpine form of folding of Heim are taken as types; mountain uplift generally being classified under symmetrical, unsymmetrical (*sic*), and compound types. The second of this group treats of the sculpture of mountains, forestalling, somewhat, the subsequent

chapter on the formation of valleys; and the last of the chapters on mountains deal very fully and clearly with the origin of certain forms. The observations on p. 82 regarding the tendency of vegetation to convert the typical concave denudation curve into a convex curve is, we believe, here suggested for the first time, and a study of photographs, depicting forest-clad valleys, appears completely to bear out this theory of Mr. Marr. Admirable as is the description of the development of a typical mountain range, it would, we think, be still more easily followed by the reader were orographical sketch-maps of the Monta Rosa and Scawfell districts added in a future edition.

In the chapters which follow on valleys, the reader is introduced to the latest American nomenclature of consequent, subsequent, obsequent, inconsequent, and antecedent valleys; corrasion, comminution, peneplain, etc. Many of these terms are, no doubt, useful, but it is interesting to note that the very inexpressive term 'watershed' is still retained, and that no Anglo-Saxon word has yet been coined to denote the course of a river represented by the German word 'Thalweg.'

Chapters xi and xii, which deal with lakes, are perhaps the most interesting in the book, our author himself having written largely on the subject, and being our greatest authority on our own lake district. In this connection we are glad to see Mr. Marr referring to the work of that excellent old author Jonathan Otley.

The chapters on Plains and Deserts are also very fully treated of, and a long way ahead of the chapters on these subjects usually found in textbooks; in fact, it is wonderful how much up-to-date information the author has compressed into his little book.

The chapters devoted to Ice are perhaps a little curtailed compared with other portions of the subject, and we would call attention to the scant notice given to the work of avalanches, although it has been estimated by Inspector Coaz that one-third of the snow which annually falls on the St. Gothard range is removed by avalanches. We should like also to see a reference to Heim's work on 'Gletscherkunde' and the observations of the Rhône Glacier Commission. Upon the vexed question of the coincidence of lake basins and ancient glaciers, we are glad to see Mr. Marr reminding his readers of a fact long ago pointed out by Sir Charles Lyell, viz., that in a region undergoing elevation glaciation will often prevent the water-ways from being kept open by rivers during the uplift; and in this way lakes may be formed. Such lakes, then, will be caused, not by the erosion of ice, but by the absence of erosion by water, owing to the presence of the ice.

The book has been designed to interest the general reader as well as to assist the student, and the changes of styles in neighbouring paragraphs are in consequence perhaps occasionally rather abrupt.

On the whole, if we might offer a suggestion on what is evidently a very conscientiously written work, it would be in favour of a somewhat less technical treatment, with, however, full references to works where the details of the subject may be consulted, bearing

in mind the requirements of the intelligent general reader whom it is desired to convert into a student of the subject. That the writer is imbued with a true love of scenery is abundantly evident in many passages, and the feeling of the book is throughout conceived in the spirit of such classical exponents of the scientific beauties of scenery as Forbes, Tyndall, Ruskin, and Geikie; and in passages, as for instance on p. 201, in which the play of colours observed on Windermere is described, and again in his concluding chapter on the preservation of natural beauties, the author shows himself capable of the highest appreciation for the poetry of his subject.

The verbal slips in the book are few and insignificant. We would call attention to 'windward' on p. 264, for which 'leaward' is evidently intended; the letter S has been omitted in fig. 14, although alluded to in the legend; it would facilitate reference from the text if the plates were numbered; on p. 273 the reader might conclude that the hexagonal and rhombohedral systems were separate and distinct. In alluding to the evaporation of snow and camphor the process is referred to as 'sublimation.' In Watt's Dictionary of Chemistry sublimate is defined as "a body obtained in the solid state by the cooling of its vapour." Again, on p. 278 we have a curious sentence on the angle of accumulation of snow which concludes "the latter" (the aiguilles), "being at an elevation inferior to that of the topmost dome." Surely, as the Germans say, "das versteht sich."

The photographic illustrations have been carefully selected and excellently reproduced; they are all to the point, and fully described in the text, an innovation on the usual method, on which we beg to congratulate the author, as indeed we do most heartily on the whole work, and we recommend it most thoroughly to all true lovers of scenery, both general and scientific.

II. — Correlation between Tertiary Mammal Horizons of Europe and America. An Introduction to the more exact Investigation of Tertiary Zoögeography. Preliminary Study with Third Trial Sheet.—Two Presidential Addresses before the New York Academy of Sciences.—By Henry Fairfield Osborn. (Annals N.Y. Acad. Sci., vol. xiii, No. 1, pp. 1–72, July 21, 1900.)

WE heartily agree with Professor Osborn that no-one can oppose the immediate adoption of the fundamental principle that the old and new world palæontology should be studied as a unit: although considerable time must elapse before a consensus of opinion can be arrived at, there is no doubt that the best way is to set to work *viribus unitis*. Professor Osborn has taken the lead, and well he may; for he is better acquainted with the Tertiary mammal horizons of Europe than any one of his European colleagues with those of the new world.

In 1897 and 1898 he drew up and circulated for criticism amongst old-world palæontologists two successive trial sheets "of the typical and homotaxial Tertiary horizons of Europe";

a third trial sheet was issued in connection with the first of the two addresses above quoted. We here transcribe the "Preliminary Table of European and American Tertiary Horizons," being an abbreviation of the third trial sheet.

Lyell's System.			Approximate American Parallels.
Pleistocene	Upper:	Post-Glacial	
	Middle:	Glacial and Interglacial	
	Lower:	Preglacial	? *Equus* beds.
Pliocene	Upper:	Sicilien	? Blanco.
	Middle	Astien. Plaisancien.	
	Lower:	Messinien	Upper Loup Fork.
Miocene	Upper:	Tortonien	Loup Fork.
	Middle:	Helvetien	Lower Loup Fork and
	Lower:	Langhien	Upper John Day.
Oligocene	Upper:	Aquitanien	Lower John Day (*Diceratherium* Layer).
	Lower	Stampien / Infra Tongrien	White River.
Eocene	Upper:	Ligurien	Bridger and Uinta.
	Middle	Bartonien ... ... / Lutétien	Lower Bridger. / Wind River.
	Lower:	Suessonien	Wasatch.
	Basal	Thanetien ... ... / Montien	Torrejon. / Puerco.

"In all the levels above the Stampien the parallels are imperfectly established." "Our Pliocene record, as compared with the magnificent Pliocene of Europe, is extremely meagre, and our Miocene succession, rich as it is, is not as fully understood as the Miocene of France."

In Part I the parallels between Tertiary horizons are discussed.

The Burdigalien, Lower Miocene, calls for a few remarks. Gaudry was the first to place the *Calcaire de Montabuzard* and the *Sables de l'Orléanais* in a lower level than Sansan, '*Anthracotherium*' not being found and the ruminants being more evolved in the Sansan deposit. The Proboscidea and Monkeys appear for the first time, no trace of them being found in the Upper Oligocene (Saint-Gérand-le-Puy, etc.).

Owing to the extreme scarcity of the Burdigalien fossils in other than a few French museums, most palæontologists were prevented from forming an opinion of their own; the Burdigalien for these reasons was omitted from the "Table of Contemporary Deposits, with their Characteristic Genera of Mammalia," published in the Geological Magazine (1899, p. 61). The general tendency has been to leave the *Sables de l'Orléanais* in the same horizon as Sansan, La Grive, Steinheim, with which they were and still are supposed to share such characteristic Tortonien species as *Dinotherium bavaricum*, *Mastodon angustidens*, and *Anchitherium aurelianense*. The more recent researches of Depéret, the results of which are endorsed by Osborn, have confirmed Gaudry's views. Some vertebrates from the Burdigalien of Moghara (Lower Egypt) have of late been described by Andrews.

The Burdigalien fauna will doubtless appear more distinct when the remains of the above-mentioned genera and others have been more closely examined.

Both the Proboscideans from the *Sables de l'Orléanais*, mentioned above, are smaller than the species of the Tortonien from which their names have been borrowed; furthermore, the *Dinotherium* of the Burdigalien received a specific name (*D. Cuvieri*, Kaup) long ago. The late Abbé Bourgeois' collection in the College of Pontlevoy (Loir-et-Cher) contains, it is true, in addition to undoubted Burdigalien forms, several *Mastodon*-teeth from the Faluns of Pontlevoy and Thenay, which seem indistinguishable from those of *Mastodon angustidens*. The Faluns belong to the Helvetien, and the presence of Burdigalien forms must be accounted for by supposing that they have been derived from that deposit, the fauna, in fact, apparently including both derived and contemporary forms of terrestrial Mammalia.

The *Anchitherium* was named (*A. aurelianense*) after the specimens from the *Calcaire de Montabuzard*: the detailed descriptions are based on specimens from the Tortonien. The *Anchitherium* remains from the *Sables de l'Orléanais* will presumably prove to be a less specialized stage in the Equine series than those of the Tortonien.

As to the Suidæ from the *Sables de l'Orléanais*, they have been shown by H. Stehlin to be distinct from those of the Aquitanien as well as from the Tortonien Suidæ.

The Lagomorphous Rodent of the Burdigalien is not a *Titanomys*, for it has rootless cheek-teeth; it is not a *Prolagus*, for its lower cheek-teeth are five in number, not four. In the above characters and in the general conformation of the upper middle premolar, it agrees with *Lagopsis* and *Lagomys*. But it differs from *Lagomys* and from the only known species of *Lagopsis* (*L. verus* from the Tortonien) in the pattern of the anterior lower premolar.

Part II deals with the "Faunal Relations of Europe and America during the Tertiary Period and Theory of the successive invasions of an African Fauna into Europe." In the chapter "Tertiary Geographical Distribution" we notice the omission of two important papers bearing on the subject. Referring to the hypothetical "Continent Antarctica," the author says: "Following Blanford (1890), Forbes (1893) made the first strong plea for this continent." The first strong plea, and with several sounder arguments than some of those advanced in recent years, was made as long ago as 1867 by Rütimeyer,[1] whose masterly sketch is at the same time the strongest possible appeal to set zoogeography on a palæontological basis. Rütimeyer ultimately divides the world in a northern and southern division (op. cit., p. 15 and map), which do not quite coincide with the Northern and Southern Hemisphere, and are therefore in better agreement with the known facts than Huxley's *Arctogæa* and *Notogæa* (1868). Rütimeyer's dual division is also more consistent with the hypothesis of an Antarctic continent than Blanford's three divisions.

[1] "Über die Herkunft unserer Thierwelt. Eine zoogeographische Skizze" (1867).

Osborn's theory of successive invasions of an African fauna into Europe seems at first sight a very bold one. "It thus appears that the Proboscidea, Hyracoidea, certain edentata, the antelopes, the giraffes, the hippopotami, the most specialized ruminants, and among the rodents, the anomalures, dormice, and jerboas, among monkeys the baboons, may all have enjoyed their original adaptative radiation in Africa." Three, or rather four, successive migrations are supposed to have taken place, the first in the Upper Eocene, the last in the Upper Pliocene. A similar theory cannot, of course, be imagined if the permanence of continents and oceans is maintained, so that Osborn's theory is in the main a clever elaboration of the 'Lemuria' hypothesis, in its original form, as conceived by P. L. Sclater.[1] This is the second of the two papers above referred to as having been omitted by the author. A southern origin has, moreover, been advocated for the Proboscidea in Neumayr's "Erdgeschichte," and for the Cercopithecidæ in the GEOLOGICAL MAGAZINE (1896, p. 436), partly with the same arguments advanced by Osborn (p. 58).

But, if South Africa is a great centre of independent evolution (p. 57), and has supplied South America with the edentates, as well as the "stem forms of its Ungulates" (p. 54), why leave it in the Arctogæa, whilst 'Neogæa' is made to stand apart? This is our reason for objecting to 'Neogæa.' C. F. M.

III. — ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION FOR THE YEAR ENDING JUNE 30, 1897. 8vo; pp. 38 and 1,024. S. P. LANGLEY, Secretary Smithsonian Institution. (Washington, 1899.)

Part I. Report upon the Condition and Progress of the U.S. National Museum during the year ending June 30, 1897, by Charles D. Walcott, in charge of the U.S. National Museum. pp. 1–246.

Part II. Papers Describing and Illustrating Collections in the U.S. National Museum.

(A) Recent Foraminifera. A descriptive Catalogue of specimens dredged by the U.S. Fish Commission Steamer "Albatross," by James Flint, M.D., U.S. Navy, Hon. Curator Division of Medicine, U.S. National Museum. pp. 247–350, and 80 plates.

(B) Pipes and Smoking Customs of the American Aborigines, based on material in the U.S. National Museum, by Joseph D. McGuire, Ellicott City, Maryland. pp. 351–646, 4 plates, a frontispiece, and 239 figures in the text.

(C) Catalogue of the series illustrating the Properties of Minerals, by Wirt Tassin, Assistant Curator of Mineralogy. pp. 647–688.

(D) Te Pito Te Henua, known as Rapa Nui; commonly called Easter Island, South Pacific Ocean. Latitude, 27° 10′ S.; longitude, 109° 26′ W. By George H. Cooke, Surgeon U.S.N. pp. 689–724.

[1] "The Mammals of Madagascar": Quart. Journ. Science, vol. i, pp. 213–219 (1864). The four cautiously worded deductions at which Sclater arrived may be almost entirely endorsed at the present day.

(E) The Man's Knife among the North American Indians, a study in the collection of the U.S. National Museum. by Otis Tufton Mason, Curator Division of Ethnology. pp. 725–746, with 17 illustrations.

(F) Classification of the Mineral Collections in the U.S. National Museum, by Wirt Tassin. pp. 747–810.

(G) Arrow-points, Spear-heads, and Knives of Prehistoric Times, by Thomas Wilson, LL.D., Curator Division of Prehistoric Archæology, U.S. National Museum. pp. 811–988, 65 plates, and 201 illustrations in the text. pp. 989–1022 are devoted to a general index to the whole volume.

The Board of Regents of the Smithsonian Institution are to be congratulated upon the production of an imperial octavo volume of 1,062 pages, embracing a report upon the Museum, with seven memoirs describing and illustrating various sections of the National Collection, four of which are profusely and beautifully illustrated by 149 plates and 457 process-block illustrations in the text.

PART I.

The Report itself occupies 246 pages, and is drawn up by Mr. C. D. Walcott, the Acting Assistant Secretary in charge of the U.S. National Museum. The Departments are—ANTHROPOLOGY, with 17 curators and assistants; Animal BIOLOGY, with 27 curators and assistants and 3 honorary associates; Division of PLANTS (*National Herbarium*), with 8 curators and assistants; GEOLOGY and MINERALOGY, with 18 curators and assistants. The administrative staff is represented by Mr. S. P. Langley, the Secretary and Keeper; Mr. C. D. Walcott, Acting Assistant Secretary; Mr. F. W. True, Executive Curator; and a staff of ten officers, including a photographer, a registrar, two librarians, an editor, a chief of correspondence and documents, and a chief of buildings.

Here is a sample of the *work of the Museum*. During the year covered by this report nearly 27,000 geological and biological specimens, selected from the duplicates, were distributed to universities, colleges, and schools. The publications of the Museum were also distributed at home and abroad. Identification of specimens is also undertaken, except when analyses of geological specimens are desired; these the Museum cannot perform.

Letters containing requests for information on every conceivable topic are all carefully answered. These number from 12,000 to 15,000 a year. Public lectures are also frequently provided, or the lecture-hall placed at the disposal of Societies desiring to hold their meetings in the Museum.

To sum up, the aims of the U.S. National Museum are to promote the advancement of scientific research (1) through the medium of the collections exhibited; (2) by affording to specialists access to the 'reserve' collections; (3) by the identification of specimens; (4) through the agency of the library; (5) by the donation of specimens to educational institutions; (6) by the donation of its publications; (7) by its lecture courses; and (8) by imparting

special information through correspondence. Such is an epitome of the work carried out by the U.S. National Museum under the direction of the Smithsonian Institution.

An annual report, however good and satisfactory, is generally admitted to be a somewhat dull but necessary document, and certainly not to be classed with novels and such light literature as holiday reading: but behind the report come seven admirably prepared memoirs, which the authors have endeavoured to render as attractive as possible, not only by the varied subjects treated of, but in several instances by the excellent and abundant illustrations given.

PART II.

(A) Dr. James M. Flint, of the U.S. Navy, furnishes a descriptive catalogue of the Foraminifera dredged by the U.S. steamer "Albatross." Materials from about 125 stations have been carefully studied, and specimens from more than one hundred localities have been preserved and identified. Fifty-eight localities are in the North Atlantic Ocean, twenty-one in the Gulf of Mexico, seven in the Caribbean Sea, one in the South Pacific, and five in the North Pacific. The depths vary from 7 to 2,512 fathoms. The illustrations are all made from mounted specimens on exhibition in the U.S. National Museum, and have a uniform enlargement of about fifteen diameters; by this plan they mark distinctly the relative size of the objects. The classification followed is that of the late Mr. H. B. Brady in his Report on Foraminifera collected by H.M.S. "Challenger."

The series are mounted expressly for the public, the specimens of each species being attached to the bottom of a shallow, concave, blackened disk of brass, arranged in concentric rows upon a large circular metal plate forming the stage of an ordinary microscope. The circular plate has a rotary and a to-and-fro movement by means of a friction roller and a rack and pinion, so that all the mounts may be successively brought under the microscope. The apparatus has been in use by the public, both by adults and children, and has stood very severe tests successfully for seven years, with only the occasional presence of an Attendant in the room.

Dr. Flint gives a description of what Foraminifera are, which would do admirably for a popular guidebook. He then proceeds to explain, simply and clearly, how these minute shells are to be mounted and how sections may be prepared. For the literature he refers to Carpenter's "Introduction to the Study of the Foraminifera," to Brady's Report on the Foraminifera collected by H.M.S. "Challenger," and to C. Davies Sherborn's "Index to the Genera and Species of the Foraminifera." Then comes an analytical key to the families, followed by a descriptive catalogue of the genera and species. The eighty plates are superb, and demonstrate what can be satisfactorily done by photography *direct*, without the intervention of any artist. The photographs are only 'processed,' and then printed on good plate paper.

The figures of *Astrorhiza* (plates i–iii), whose chambers and tubes are built up of agglutinated grains of sand, are remarkably effective, as are also those of *Pilulina Jeffreysi*. Where all are so excellent it would be difficult to specially select for praise certain plates; but we may mention *Reophax* (plates xvi–xviii), *Haplophragmium* (xix–xxi), *Ammodiscus* (xxiii), *Hormosina* (xxv), *Cyclammina* (xxvii), *Gaudryina* (xxxiii), *Clavulina* (xxxiv–xxxvi), *Biloculina* (xxxviii–xl), *Spiroloculina* (xlii, xliii), *Peneroplis* (xlix), *Orbitoides* (l–lii), *Nodosaria* (lv–lviii, superb), *Cristellaria* (lxvi, lxvii), *Pulvinulina* (lxxv), *Rotalia* (lxxvi). We agree with the author in thinking that some of the more minute forms, such as *Truncatulina*, *Anomalina*, *Discorbina*, *Uvigerina*, etc., would have shown to greater advantage if they had been magnified more highly, but the work is, as a whole, most excellent.

(B) Under the division of Ethnology Mr. Joseph D. McGuire gives us an interesting and well-illustrated memoir on "Pipes and Smoking Customs of the American Aborigines," based on materials in the U.S. National Museum and elsewhere. There are 239 illustrations of pipes in the text, a frontispiece, and 4 maps showing the distribution of objects over the United States.

Tobacco cannot be considered a geological product (although largely consumed by geologists!), yet the material out of which the ancient stone pipes of North America were manufactured is not without interest, from a strictly scientific point of view, to non-smokers among geologists and antiquaries. Indeed, in fig. 64 is depicted a fossil pipe from Pottawatomie, Kansas, made of the outer whorl of an Ammonite (probably *Schlœnbachia Peruviana* or *acuticarinata*), the shape of which probably attracted the curiosity of the Indians.

Another material largely used was 'Catlinite,' a red clay forming beds of considerable extent in Pipestone County, in the south-western part of Minnesota (named after the writer on the American Indians, George Catlin). In addition, we may quote banded green slate, steatite, greenstone, a concretion, volcanic tuff, sandstone, pipe of stalagmite, of mica, obsidian, jade, porphyry, and Oolitic limestone as among the materials used. But clay of various kinds (moulded and afterwards kilned) was also very largely in demand.

Of the figure pipes many were no doubt 'totems' of the tribes, as the hawk, dog, frog, turtle, raccoon, eagle, duck, pigeon, swan, snake, human hands and head. A pipe shaped like an elephant[1] is very puzzling, for it implies, if genuine, that the designer was acquainted with the animal, which seems incredible for a Mound-Indian of Iowa, or that it was of *later date*, in fact a European workman's fabrication of the same dishonest type as the 'antiquities' made by the celebrated English impostor known as 'Flint Jack.' Of other materials for the manufacture of pipes we may mention wood, wood and stone, wood and lead pipe, a combination of clay, copper, and wood, a pipe of willow, a pipe of bone, of copper, of lead, a combination of stone and bone, a bronze pipe, a brazed iron pipe,

[1] Could it have been a mammoth or a mastodon which the artist had seen, or was it a modern Indian elephant he had copied?

a tomahawk and pipe combined of iron or steel. The simplest form of pipe known is that in use in Ladak and Thibet, where the natives, in travelling, make a small, smooth hole in the ground, which they fill with tobacco, and then make a connecting hole through which they draw the smoke directly into the mouth, the ground itself serving the part of a pipe. The present writer was informed by Sir John Kirk that the Kaffirs in East Africa do precisely the same when travelling; the ground being first wetted, then the bowl is formed by the thumb being pressed vertically into the earth, and the tube for inhaling the smoke is made by the little finger, which is pressed in obliquely until it touches the base of the larger hole.

Of the religious, civil, military, trade, and domestic functions in which the 'calumet' or peace-pipe was introduced amongst the North American Indians, forming an important part of all such ceremonies, let those who are interested to learn, read Mr. Joseph McGuire's admirable memoir. We have room for only one quotation by way of illustration: "In 1682, when William Penn landed in New Jersey, he received the lighted calumet or pipe, which was smoked out of by all; the great sachem first taking a whiff, then William Penn, and subsequently the sachems and warriors and squaws of every tribe. A second smoke closed the bargain for the purchase of land; and 300 tobacco pipes, 100 hands of tobacco, 20 tobacco boxes, and 100 *jew's-harps* were a portion of the articles given in exchange" (p. 461). We had no idea that the jew's-harp, or indeed any other musical instrument, had been 'traded' by the Quakers to the North American Indians. It suggests that our quiet friends must have secretly had a taste for music, even two hundred years ago!

(C) The next memoir is a catalogue illustrating the properties of minerals, by Wirt Tassin, Assistant Curator, Department of Mineralogy, Smithsonian Museum.

The plan of arrangement followed deals with (1) chemical mineralogy, such as the chemical composition or atomic structure of a mineral and the chemical relations of the several kinds of minerals; and (2) physical mineralogy, which treats of those properties relating to form or molecular structure of a mineral, and the action of the various physical forces upon the several kinds of minerals.

Under chemical mineralogy the author treats of the elements, and explains that all minerals are composed of either an element alone or two or more elements in combination; that such combinations of simple substances may produce a new substance, differing from and possessing properties not the mean of those of its constituents. This is illustrated by the gases hydrogen and oxygen, which under proper conditions combine to form water, a liquid. Then follow examples of various minerals, as zinc and its combinations, tin and its combinations, lead and its combinations, sulphur and its combinations, iron and its combinations, and so on. The author next gives types of minerals and examples of native elements, as carbon, sulphur, the metals platinum, mercury, copper, silver, and

gold, and the alloys of each. Next the variations in composition are considered, and the relation of water to composition and to physical properties; then the relation of composition to physical properties, such as density, magnetism, and lustre.

Physical mineralogy is next treated of, and we have a brief essay on the crystal, on crystallographic axes, on crystal form and crystal systems, etc.; characters relating to cohesion and elasticity, characters depending upon mass or volume; properties relating to heat, magnetism, and electricity; optical characters depending upon the action of light, etc., and characters depending upon the action of the senses, as touch, taste, odour; and lastly, on resistance to chemical action.

(F) By an accident of arrangement, Mr. Wirt Tassin's second part, "Classification of the Mineral Collections in the U.S. National Museum," has been separated by the interpolation of two other essays (D and E): we will, however, notice this part (F) next to part C. Classification 1, Elements. Of the seventy or more elements at present known to chemistry, but eighteen, excluding those occurring only in the gaseous state, are found native. With the native elements are included the native alloys, or compounds and mixtures of elements belonging to the same groups in the periodic system.

A list of these native elements is then given, with their native alloys and compounds, in groups, as (1) diamond, bort, carbonado, graphite, schungite, graphitoid, cliftonite; (2) sulphur (and its compounds), selenium, tellurium, etc.; (3) arsenic, etc., antimony, bismuth; (4) tin, lead; (5) iron, catarinite, etc.; (6) platinum, platiridium, iridium, osmiridium, palladium, etc.; (7) mercury, amalgam, copper, silver, gold, electrum, porpezite, rhodite.

These are followed by compounds of the elements, as (A) compounds of halogens-fluorine, chlorine, bromine, and iodine; (B) compounds of sulphur, selenium, and tellurium, also arsenic, antimony, bismuth, and germanium; (C) oxygen compounds; (D) compounds of organic origin (as mineral wax, fossil resins), asphaltum, mineral oils, coals, etc., and the salts of the organic acids, oxalates, and mellates. A full index of minerals is given at the end.

These papers by Mr. Wirt Tassin are likely to prove useful to the curators of minerals in other museums seeking a plan of arrangement for their collection. We can also strongly recommend (1) the admirable Introduction to the Study of Minerals, by L. Fletcher (price 3*d.*), British Museum (Natural History), with a guide to the Mineral Gallery (pp. 120, 8vo); (2) Introduction to a Study of Meteorites, by L. Fletcher (price 3*d.*, pp. 92, 8vo); (3) Introduction to a Study of Rocks, by L. Fletcher (price 6*d.*), British Museum (Natural History), (pp. 118, 8vo).

(D) Mr. George H. Cooke, surgeon, U.S. Navy, supplies us with an interesting account of Easter Island in the South Pacific Ocean. The U.S. steamer "Mohican" sailed from Callao, Peru, March 6th, 1868 (? 1886), under orders for a protracted cruise, on special duty, among the islands of the South Pacific, with instructions

on her return passage to the South American coast to call at Easter Island, make certain investigations desired by the Smithsonian Institution, and especially to bring away one of the colossal stone images to be found upon the island. The stone image, stone crown, and stone head having been successfully transported over the island to the beach and thence transferred on board, the ship sailed on the last day of the year for Valparaiso, Chile, arriving on January 14th, 1887. There appears to be a misprint in the first *year* recorded here, for on p. 692 the author says: "The investigations upon which this report is based cover a period of *twelve days* from December 19 to December 30, 1886, inclusive."

On December 18th the extinct crater of Rana Kao was visited, and a general inspection was made of the stone huts, the painted slabs in their interior, the sculptured rocks, etc., and of the crater itself, in the immediate vicinity of which these objects of interest are located. Here numerous finished and unfinished images, some standing, others prostrate, were seen scattered over the slope of the crater and the great plain at its base, where there is every reason to believe once stood a populous town. The quarries, or 'workshops,' were also visited, and the many partly completed monoliths still attached to the original rock were examined. As in Egypt, where in the quarries at Syene, near the First Cataract, the largest obelisk still lies unfinished, so here, in one of the excavations on the outer slope of the crater, may be seen the largest of the stone images to be found on Rapa Nui in an incomplete condition, still adherent to the bed rock, and measuring 69 ft. 9 in. in length! carved in trachyte. Mr. Salmon and Mr. Brander seem at present to be the sole proprietors on the island, with a stock of 18,000 head of sheep and many cattle. The population now consists of 155 natives and 11 foreigners (two English, two Americans, one Frenchman, and six Tahitans), yet from 1850 to 1860 the number of inhabitants was said to be 20,000. In 1863 the Peruvians carried off 5,000 of the inhabitants to work the guano deposits of the Chincha Islands. Some few only of these returned alive, smallpox having broken out on the return voyage; it also ravaged the island, many deaths resulting therefrom.

With regard to the ancient inhabitants—the makers of the trachyte quarries, the builders of the stone houses, and the carvers of the colossal stone images—the number and extent of their works are so great that one is led to ask how they came suddenly to an end, which must have been the case judging by the large number of images in all stages of development seen at Rana Roraka, where the ancient town once existed, and in the quarries in an unfinished condition both inside and outside of the adjacent crater slopes. The present natives neither carve, nor quarry stone, nor build.

If we take note of the vast number of volcanic stones evenly scattered over the surface of the island, especially the eastern half, one is led to the inevitable conclusion that either the volcano of Rana Roraka, or one of the neighbouring volcanoes, suddenly became active and threw out these showers of stones, probably destroying

many lives, and so stopped the labours of the workmen, which were thenceforth never resumed. Perhaps, too, the same calamity overthrew, by an earthquake, many of the idols (of which not one is now standing on its pedestal), laid waste the island, and wrought the destruction of the trees which once adorned it, and from the period of that disaster probably dates the decadence of the ancient people of Tepito Te Henua. The island contains several distinct craters, the highest point being 1,970 feet. The great crater of Rana Kao has a lake in its centre 300 feet in depth, with a circumference at its surface of $2\frac{1}{2}$ miles, so that good drinking water sufficient for a large population exists on the island.

(E) Mr. Otis Tufton Mason describes the man's knife among the North American Indians as illustrated by the collections in the U.S. National Museum. Knives, strictly speaking, are adapted for industrial purposes, and therefore belong to the category of *tools*, not weapons. If, however, a knife is used as a weapon for destruction, it should be classed as a dagger, but when employed as an edged tool it is properly described as a knife. The edge tool works by pressure, by friction, or by a blow. One used by means of a blow is an axe if the edge is in a line with the handle, and an adze if it lies across the handle; an edged tool working by friction is a scraper, but one working by pressure is a knife. Although the iron or steel-bladed knife has been only in the hands of Eskimo, of Canadians, and tribes of the United States and the North Pacific, for a century or two they seem to have thoroughly mastered its use as a tool. They are nearly all curved-bladed, and the hafting is always native, the blade alone (whether of steel or iron) being foreign. Before the possession of iron there is meagre evidence that any of these native races possessed other than the most trivial carvings in hard material. Their best works were in soft wood and slate, by means of the beaver's tooth or shark's tooth knives. Mr. Mason does not mention the use of flint or obsidian, but one knife with a glass blade from Patagonia is recorded.

(G) "Arrow-points, Spear-heads, and Knives of Prehistoric Times," by Dr. Thomas Wilson, Curator of Prehistoric Archæology, U.S. National Museum. Dr. Wilson's memoir is one of the most elaborate in this volume and covers 177 pages. It describes and illustrates spears and harpoons in the Palæolithic period; the origin of the bow and arrow; superstitions concerning arrow-points and stone implements. In the island of Guernsey the stone implements are called 'lightning-stones' and 'thunder-stones' (*pierre de foudre* or *pierre de tonnerre*), and are firmly believed in as a protection against fire. The flint mines and quarries in Europe and America are described; a most interesting account is given (illustrated by many plates) of the materials used in making arrow-points and spear-heads, showing the microscopic structure of the materials. The manufacture of arrow-points and spear-heads is explained, and the various scrapers, grinders, and straighteners used in making arrow and spear shafts. All the varied patterns of arrow-heads and spear-heads are arranged, classified, and elaborately figured,

and some 25 types are enumerated. Flint knives are next considered. Large implements of arrow-point or spear-head form are described, and the making of arrow-points is shown. Sixty-five plates and 201 text-figures are devoted to the illustration of this valuable memoir. It is impossible to give an adequate idea of the beauty and excellence of the illustrations, but we commend Dr. Wilson's memoir to all who are interested in the subject of Prehistoric Archæology.

REPORTS AND PROCEEDINGS.

Geological Society of London.

June 20, 1900.—J. J. H. Teall, Esq., M.A., F.R.S., President, in the Chair.

The President announced that the Foreign Secretary had received the following letter from Professor A. Gaudry, F.M.G.S., President of the Organizing Committee of the Eighth International Geological Congress:—

"My dear Friend,—We have just published the Guide-book to the excursions in France of the International Geological Congress. It occupies over 1000 pages, and is full of beautiful illustrations and of geological sections and maps. The excursions will extend over the whole of France from the North as far as the Central Plateau, the Alps, and the Pyrenees. As you are the Foreign Secretary of the Geological Society of London, equally honoured and loved in England and in France, I think that no one is in a better position than you to beg of the Fellows of the Geological Society of London to come in large numbers to Paris. All our geologists will be honoured in seeing them, and will be happy to receive their opinions. To have any great authority it is necessary that an International Geological Congress should have your country — where Geology has been so magnificently studied—largely represented. You can tell our brethren of the Geological Society of London that the President of the Organizing Committee of the Congress of 1900 is the oldest of the Foreign Members inscribed upon their list, that he is a former recipient of the Wollaston Medal, a Foreign Member of the Royal Society of London, and that among his scientific acquaintance he has not a better friend than you. This will be as much as to tell them that I am attached to them by the bonds of deep gratitude, and that it will be a happiness for me to welcome them in our ancient city of Paris. I reckon upon you.—Yours most sincerely, Albert Gaudry."

The following communications were read:—

1. "On the Skeleton of a Theriodont Reptile from the Baviaans River (Cape Colony)." By Professor H. G. Seeley, F.R.S., F.L.S., V.P.G.S.

The fossil described in this paper was discovered by Mr. W. Pringle at Ealdon, in the bed of the Baviaans River, a tributary

of the Great Fish River. It is now preserved in the Albany Museum. The slab containing it is of hard siliceous sandstone, and is 31 inches long by ten inches wide. It is split so as to expose a portion of the skull, the vertebral column and ribs as far as the pelvis, the scapula, part of the humerus, the femur, and parts of the tibia and fibula. The tail and left hind-limb, and apparently part of the right fore-limb, are lost, owing to the jointed condition of the rock. The bones have decomposed, and are represented by natural moulds from which a beautiful cast was obtained by means of a gelatine mould prepared in the Geological Department of the Natural History Museum, before the specimen was returned to Grahamstown. It indicates an animal about 2 feet long, exclusive of the tail, and standing probably about 8 inches high; it was not more than 6 inches wide in the fore part of the body. The animal was of great mobility, capable of easily bending the body, and, by straightening the limbs, of occasionally raising its height to 10 inches or more. It is a new type of Theriodont reptile, contributing important facts to the osteology of the group, and especially in regard to the natural association of the bones. It is possibly to be included in the Cynodontia, from which it differs in characters of the ilium, scapula, and skull.

2. "Fossils in the Oxford University Museum.—IV. Notes on some Undescribed Trilobites." By H. H. Thomas, Esq., B.A., F.G.S.

Two new species of *Dalmania* from the Wenlock Shales and one of *Olenus* from the Shineton Shales of Shropshire are described in this paper. The specimens on which the first species of *Dalmania* is founded were collected by the late Dr. Grindrod at Malvern Tunnel. The species has a strong resemblance to certain varieties of *D. caudatus*, especially those more nearly approaching *D. longicaudatus*; its nearest ally seems to be *D. nexilis*. Among its characters are spines round the head, the height of the head-shield, and the distance between the eyes. The type-specimen of the second species came from the Wenlock Shale of Builth. The Shineton specimen was presented to the Oxford Museum by the Right Rev. Bishop Mitchinson.

3. "On Radiolaria from the Upper Chalk at Coulsdon (Surrey)." By W. Murton Holmes, Esq. (Communicated by W. Whitaker, Esq., F.R.S., F.G.S.)

The radiolaria described in this paper were contained in the cavities of two small flints which were thrown out of the new cutting between Coulsdon Station and the new Merstham Tunnel on the L.B. & S.C. Railway. They were probably derived from the zone of *Holaster planus*. After treatment with hydrochloric acid, the material yielded silicified casts of foraminifera as well as radiolaria. The surface of the radiolaria is so much altered by corrosion that specific identification is in most cases impossible. Twenty genera have been recognized, and the organisms appear to belong to forty-one species of these genera. A list of the radiolaria is given, accompanied by a short description of each form, and four new

species are described. The Discoidea appear to have the predominance, and the species of *Dictyomitra* come next in numerical order.

The next Meeting of the Society will be held on Wednesday, November 7th, 1900.

OBITUARY.

PROFESSOR M. LOUIS LARTET.

Born 1840. Died 1899.

Professor Louis Lartet was the son of a former distinguished Foreign Member of the Geological Society of London, Monsieur Edmund Lartet. In 1863 he assisted De Verneuil in the publication of two papers, and from 1864 to 1868 he published several others, chiefly on the Holy Land, leading up to his lengthy essay of 1869 on the Geology of Palestine and of the neighbouring countries, followed, three years later, by a shorter paper on the Palæontology. In 1877 his work was presented in a more elaborate form in the large quarto volume entitled "Geological Exploration of the Dead Sea, of Palestine, and of Idumea," with two geological maps, three plates of sections, and eight of fossils and of stone implements. By these works he is chiefly known. Professor Louis Lartet was elected a Foreign Correspondent of the Geological Society of London in 1882, and died in 1899.

SIR DOUGLAS S. GALTON, K.C.B., F.R.S., F.G.S.

Born 1822. Died March 10, 1899.

Douglas Galton was born in 1822 at Hadzor House, Worcestershire. At the age of 15 he went to the Royal Military Academy, and in 1840 got his commission in the Royal Engineers, greatly distinguishing himself and gaining the first prize in every subject of examination. He was engaged in the attempt to raise the "Royal George." He served on the Ordnance Survey and did much work in connection with railway engineering, metropolitan drainage, submarine cables, and the sanitary condition of the Army, serving on various Royal Commissions, etc. In 1860 he was made Assistant Inspector General of Fortifications, and in 1862 Assistant Under Secretary of State for War, a post which he held eight years, when he became Director of Public Works and Buildings (under the Board of Works), in which official capacity he served until 1875. He was General Secretary of the British Association from 1871 to 1895, and in the latter year he became President. In 1894 he was made Hon. Mem. Inst. C.E.; many other honours were conferred upon him, including various foreign orders. The later years of his life were specially devoted to sanitary science, for which he did very much, and his last official appearance in public was as president of a meeting of the Sanitary Institute, for the reading of a paper on the water-supply of London. He was then rather indisposed, though nothing serious was suspected; but he got weaker, and blood-poisoning set

in. He was buried at Hadzor, Worcestershire. Douglas Galton was amongst the oldest Fellows of the Geological Society, having been elected in 1848, and served on the Council from 1870 to 1874.

FRANZ RITTER VON HAUER.

BORN, VIENNA, JAN. 30, 1822. DIED MARCH 20, 1899.

RITTER VON HAUER has been called the Nestor of Austrian geologists, having been for many years Director of the Geological Survey and Intendant of the Imperial Natural History Museum. He was born in Vienna in 1822, and educated there until he went to the Berg-Akademie at Schemnitz from 1839 to 1843. He afterwards became a mining official in Styria, and in 1846 was made Assistant to Haidinger at the Imperial Mineralogical Museum in his native city, when he began original palæontological work. He succeeded Haidinger as chief of the Museum, and held that post from 1867 to 1885. On the death of F. von Hochstetter he was made Curator of the Imperial Natural History Museum, in which post he did important work, retiring at last on account of old age and ill-health. He was the first to classify the Alpine sedimentary rocks on a strictly stratigraphical basis, and published a work on the Cephalopoda of the Triassic and Jurassic beds of the eastern Alpine regions. His general map of the Austrian Empire (in twelve sheets, published 1867–71, reaching a fourth and extended edition in 1884), and his account of the geology of that empire, published in 1875, crown his life's work. Franz Ritter von Hauer was elected a Foreign Correspondent of the Geological Society of London in 1863, a Foreign Member in 1871; and he was awarded the Wollaston Medal in 1882. He died on March 20, 1899. Von Hauer received many orders and honours, held various offices, and was revered as a teacher and leader in science.

CHARLES JULES EDME BRONGNIART.

BORN 1859. DIED APRIL 18, 1899.

M. CHARLES BRONGNIART was the grandson of the illustrious French Botanist, Adolphe T. Brongniart, who in 1841 received the Wollaston Medal from the Geological Society of London. He was an Assistant at the Museum of Natural History, Paris, and was one of the chief European authorities on Fossil Insects, on which he wrote a number of papers from 1876 onward. His principal work was published in 1893, in the form of two large quarto volumes with atlases of plates. One of these is the third volume of "Studies on the Coal-measures of Commentry," which is devoted to the Entomological Fauna of the Carboniferous epoch. The other is "Fossil Insects of Primary Times." Several of his papers appeared as translations in the GEOLOGICAL MAGAZINE. (See GEOL. MAG., 1879, Dec. II, Vol. VI, pp. 97–102, Pl. IV; 1885, Dec. III, Vol. II, pp. 481–491, Pl. XII; 1888, pp. 422–425, one page illustration; 1895, pp. 233–236.) It is sad that so distinguished a career, from which we had reason to expect so much more valuable work, should

have been ended so early. CHARLES BRONGNIART was elected a Foreign Correspondent of the Geological Society of London in 1888, and died April 18, 1899, aged 40.

TOWNSHEND MONCKTON HALL, F.G.S.

BORN MARCH 22, 1845. DIED JULY 1, 1899.

TOWNSHEND HALL was born at Torquay in 1845, and studied for a short time at Wadham College, Oxford. On leaving there he gave himself up to science, and especially to geology. A paper by him on the distribution of fossils in the North Devon Series was printed in the Quarterly Journal of the Geological Society (1867, vol. xxiii, pp. 371–381); but his chief contributions to the geology and mineralogy of his native county are in the Trans. Devon Association (of which he was a member from the first), and include papers on mineral localities, raised beaches, submerged forests, concentric lamination, mineral oil, classification of North Devon rocks, and various matters of local geology. He also contributed to the GEOLOGICAL MAGAZINE and to the Mineralogical Magazine, and wrote several sketches of the Geology of Devonshire or parts thereof, and the "Mineralogists' Directory." He became, indeed, well known as our chief local authority on North Devon.

PROFESSOR ROBERT W. BUNSEN, PH.D.

BORN MARCH 13, 1811. DIED AUGUST 16, 1899.

ALTHOUGH Bunsen achieved his great reputation as a chemist, and held the Chair of Chemistry in the University of Heidelberg for many years, he wrote (especially in his earlier life) several papers on minerals and on mineral waters, as well as on various geological subjects, notably on the chemico-geology of Iceland. To the scientific world he is largely known for his work on spectrum analysis, resulting in the discovery of the elements cæsium and rubidium; whilst to the world at large he is known by the invaluable gas-burner that bears his name and the principle of which he discovered. Professor R. W. Bunsen was elected a Foreign Member of the Geological Society of London in 1856, holding the honorary distinction for 43 years. He died at the age of 88 years.

JOHN BALDRY REDMAN, F.G.S., MEMB. INST. C.E.

BORN 1816. DIED DECEMBER 21, 1899.

JOHN BALDRY REDMAN was elected an Associate of the Institution of Civil Engineers in February, 1839, and a Member in March, 1846, his name being the earliest on the roll of over 6,300 Members and Associates at the time of his death. He was elected an F.G.S. in 1882. He did much service to geology by his important papers, read to the institution above-named, "On the Alluvial Formations, and the Local Changes, of the South Coast of England," and "The East Coast between the Thames and the Wash Estuaries," published in 1854 and 1865, which were the first systematic account of the changes along a great length of our coast, in this case from Norfolk southward to Dorsetshire. Much other work of the kind was also

done by him, for instance in the Reports of the British Association Committee on Coast-erosion, and his knowledge was always at the disposal of those interested in the subject. He died at the good old age of 83.

WILHELM HEINRICH WAAGEN.

BORN JUNE 23, 1841. DIED MARCH 24, 1900.

THE celebrated palæontologist Wilhelm Heinrich Waagen was born at Munich, 23rd June, 1841, and educated there and at Zürich. In the latter place he specially studied natural history, for which he had early shown great taste.

In 1864 his first paper, "Der Jura in Franken, Schwaben, und der Schweiz," made its appearance, and gained a prize.

He established himself first at Munich, and for one year was natural history tutor to Prince Arnulph and Princess Therese of Bavaria. In December, 1870, Waagen was appointed palæontologist to the Indian Geological Survey. The Indian climate, however, did not suit him, and he was obliged to retire in August, 1875. The previous year he had contracted a fortunate and happy marriage with Sophie, Baroness von Gross-schedel.

Shortly after quitting India, Waagen settled in Vienna and became a Tutor at the University. The following year he went to Prag to occupy the Chair of Mineralogy and Geology at the German Technical High School. There, on the death of Barrande, he assisted in editing the continuation of the "Systême Silurien de Bohême," and in association with Professor J. Jahn wrote the section Crinoids for that work.

On Neumayer's death, Waagen became in 1890 Professor of Palæontology at the University of Vienna, a post which he held till his death on 24th March, 1900.

Waagen was by no means a prolific writer, less than a score of papers in various journals being written by him.

His principal works were on the Jurassic Cephalopoda of Kutch and on the Salt Range Fossils, both forming part of the "Palæontologica Indica," and the latter incomplete at the time of his decease.

Of the value of these works from a systematic point of view it is perhaps as yet too early to speak; but of his enthusiasm and industry, and of the fact that he greatly advanced our knowledge of Indian palæontology, there can be no doubt.

MISCELLANEOUS.

THE UNIVERSITY OF LONDON.—It gives us great pleasure to announce that the Senate of the University of London has conferred the degree of Doctor of Science upon Mr. C. W. Andrews, B.A., F.G.S., of the British Museum (Natural History), and has also awarded him the Sherbrooke Scholarship, founded by the late Lord Sherbrooke, Trust. Brit. Mus. This is the first occasion on which this scholarship has been presented.